



Service Manual

Reelmaster® 5010-H

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing and repair of major systems and components on the Reelmaster 5010-H (Hybrid).

REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. Space is provided in Chapter 2 of this book to insert the Operator's Manuals and Parts Catalogs for your machine. Additional copies of the Operator's Manual and Parts Catalog are available on the internet at www.Toro.com.

The Toro Company reserves the right to change product specifications or this publication without notice.



This safety symbol means DANGER, WARNING, or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.

NOTE: A **NOTE** will give general information about the correct operation, maintenance, service, testing or repair of the machine.

IMPORTANT: The **IMPORTANT** notice will give important instructions which must be followed to prevent damage to systems or components on the machine.



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KUBOTA WORKSHOP MANUAL, DIESEL ENGINE, 05- E4B SERIES	

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Safety

Product Records
and Maintenance

Kubota Diesel
Engine

Hydraulic
System

Electrical
System

Chassis

Cutting
Units

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Groomer

Foldout
Drawings

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Safety Instructions

Reelmaster machines meet or exceed safety standard specifications when weights are installed according to information in the Traction Unit Operator's Manual. Although hazard control and accident prevention are partially dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.



Before Operating

1. Review and understand the contents of the Operator's Manuals and Operator Training DVD before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. Additional copies of the Operator's Manual are available on the internet at www.Toro.com.

2. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is defective, illegible or damaged, repair or replace it before operating the machine. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.

3. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and Enable/Disable switch is OFF (disabled).

4. Since fuel is flammable, handle it carefully:

A. Store fuel in containers specifically designed for this purpose.

B. Do not remove machine fuel tank cap while engine is hot or running.

C. Do not smoke while handling fuel.

D. Fill fuel tank outdoors and only to within an inch of the top of the tank, not the filler neck. Do not overfill.

E. Replace fuel tank and fuel container caps securely after refueling machine.

F. If fuel is spilled, do not attempt to start the engine but move the machine away from the area of spillage. Avoid creating any source of ignition until fuel vapors have dissipated. Wipe up any spilled fuel.

While Operating

1. Sit on the seat when starting and operating the machine.
2. Before starting the engine:
 - A. Apply the parking brake.
 - B. Make sure the traction pedal is in NEUTRAL, the Enable/Disable switch is in the disabled position and the engine speed switch is in the mid-speed position.
 - C. Turn the ignition switch to the ON/PREHEAT position to energize the glow plugs. After allowing the glow plugs to preheat, turn the switch to the START position. Release the switch to the ON/PREHEAT position when the engine starts.
 - D. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the traction pedal linkage is adjusted incorrectly; therefore, shut engine off and adjust traction pedal linkage until machine does not move when traction pedal is released (see Traction Unit Operator's Manual).
3. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.
4. Do not touch engine, radiator, exhaust system or hydraulic components while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.
5. Before getting off the seat:
 - A. Ensure that traction pedal is in NEUTRAL.
 - B. Lower and disengage cutting units. Wait for all movement to stop.
 - C. Apply parking brake.
 - D. Move the engine speed switch to the low idle position and allow the engine to reach low idle speed.
 - E. Stop engine and remove key from ignition switch.
6. Anytime the machine is parked (short or long term), the cutting units should be lowered to the ground. This relieves pressure from the hydraulic lift circuit and eliminates the risk of the cutting units unexpectedly lowering to the ground.
7. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. Before servicing or making adjustments, lower cutting units, apply parking brake, stop engine and remove key from the ignition switch.
2. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.
3. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.
4. Make sure all hydraulic line connectors are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the hydraulic system.
5. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
6. Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by using all of the hydraulic controls with the engine not running (see Relieving Hydraulic Pressure in the General Information section of Chapter 4 - Hydraulic System).
7. Use care when checking or servicing the cutting units. Wear appropriate gloves and use caution when servicing them.
8. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.
9. If engine must be running to perform maintenance or to make an adjustment, keep hands, feet, clothing and other parts of the body away from the cutting units and other moving parts. Keep bystanders away.
10. To assure safety and accuracy, check maximum engine speed.
11. Shut engine off before checking or adding oil to the engine crankcase.
12. Disconnect 12 VDC battery located at the rear of the machine before servicing the machine. Disconnect negative battery cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive battery cable first and negative cable last.
13. Before installing, removing or working on 48 VDC system components (e.g. cutting units, motor/generator), separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of Chapter 5 - Electrical System). Plug the connector back in before operating the machine.
14. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing. Protect your face, eyes and clothing when working with a battery.
15. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.
16. When changing tires, attachments or performing other service, use correct jacks, hoists and supports. Make sure machine is parked on a solid level floor such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or appropriate load holding devices to support the raised machine. If the machine is not properly supported, the machine may move or fall, which may result in personal injury (see Jacking Instructions in this section).
17. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.
18. When welding on machine, disconnect battery cables to prevent damage to machine electronic equipment. Disconnect negative battery cable first and positive cable last. Also, disconnect wire harness connector from the TEC controller and disconnect the terminal connector from the alternator. Attach welder ground cable no more than two (2) feet (0.6 meters) from the welding location.
19. Make sure to dispose of potentially harmful waste (e.g. fuel, oil, engine coolant, filters, batteries) in an environmentally safe manner. Follow all local codes and regulations when recycling or disposing of waste.
20. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards, and the warranty may be voided.

Jacking Instructions



CAUTION

When changing tires, attachments or performing other service, use correct hoists, jacks and jack stands. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or other appropriate load holding devices to support the raised machine. If the machine is not properly supported, the machine may move or fall, which may result in personal injury.

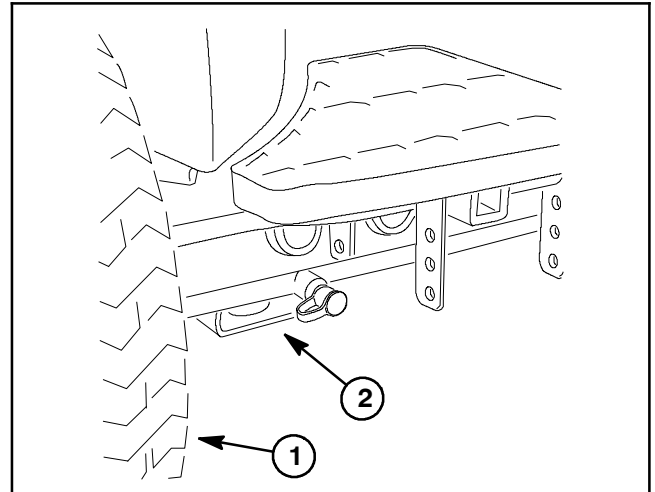


Figure 1

1. Front wheel
2. Front jacking point

Front End Jacking (Fig. 1)

1. Apply parking brake and chock both rear tires to prevent the machine from moving.
2. Position jack securely below the rectangular pad under the frame axle tube, just to the inside of the front wheel.
3. Jack front of machine off the ground.
4. Position jack stands under the frame as close to the raised wheel as possible to support the machine.

Rear End Jacking

1. Apply parking brake and chock both front tires to prevent the machine from moving.
2. Place jack securely at the center of the rear axle under the axle pivot bracket. Jack rear of machine off the ground.
3. To support the raised machine, position jack stands under the frame rail next to the axle support bracket.

Safety and Instruction Decals

Numerous safety and instruction decals are affixed to the traction unit and the cutting units of your Reelmaster. If any decal becomes illegible or damaged, install a new decal. Part numbers for decals are listed in your Part Catalogs. Order replacement decals from your Authorized Toro Distributor.



Product Records and Maintenance

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Product Records

Insert Operator’s Manual and Parts Catalog for your Reelmaster at the end of this chapter. Refer to Operator’s Manual for recommended maintenance intervals. Additionally, insert Installation Instructions, Operator’s Manuals and Parts Catalogs for any accessories that have been installed on your Reelmaster at the end of this section.

Maintenance

Maintenance procedures and recommended service intervals for your Reelmaster are covered in the Operator’s Manual. Refer to that publication when performing regular equipment maintenance. Several maintenance procedures have break- in intervals identified in the Operator’s Manual. Refer to the Engine Operator’s Manual for additional engine specific maintenance procedures.

Equivalents and Conversions

Decimal and Millimeter Equivalents

Fractions	Decimals	mm	Fractions	Decimals	mm		
	1/64	0.015625	— 0.397	33/64	0.515625	— 13.097	
	1/32	0.03125	— 0.794	17/32	0.53125	— 13.494	
	3/64	0.046875	— 1.191	35/64	0.546875	— 13.891	
1/16	—	0.0625	— 1.588	9/16	—	0.5625	— 14.288
	5/64	0.078125	— 1.984	37/64	0.578125	— 14.684	
	3/32	0.09375	— 2.381	19/32	—	0.59375	— 15.081
	7/64	0.109275	— 2.778	39/64	0.609375	— 15.478	
1/8	—	0.1250	— 3.175	5/8	—	0.6250	— 15.875
	9/64	0.140625	— 3.572	41/64	0.640625	— 16.272	
	5/32	0.15625	— 3.969	21/32	—	0.65625	— 16.669
	11/64	0.171875	— 4.366	43/64	0.671875	— 17.066	
3/16	—	0.1875	— 4.762	11/16	—	0.6875	— 17.462
	13/64	0.203125	— 5.159	45/64	0.703125	— 17.859	
	7/32	0.21875	— 5.556	23/32	—	0.71875	— 18.256
	15/64	0.234375	— 5.953	47/64	0.734375	— 18.653	
1/4	—	0.2500	— 6.350	3/4	—	0.7500	— 19.050
	17/64	0.265625	— 6.747	49/64	0.765625	— 19.447	
	9/32	0.28125	— 7.144	25/32	—	0.78125	— 19.844
	19/64	0.296875	— 7.541	51/64	0.796875	— 20.241	
5/16	—	0.3125	— 7.938	13/16	—	0.8125	— 20.638
	21/64	0.328125	— 8.334	53/64	0.828125	— 21.034	
	11/32	0.34375	— 8.731	27/32	—	0.84375	— 21.431
	23/64	0.359375	— 9.128	55/64	0.859375	— 21.828	
3/8	—	0.3750	— 9.525	7/8	—	0.8750	— 22.225
	25/64	0.390625	— 9.922	57/64	0.890625	— 22.622	
	13/32	0.40625	— 10.319	29/32	—	0.90625	— 23.019
	27/64	0.421875	— 10.716	59/64	0.921875	— 23.416	
7/16	—	0.4375	— 11.112	15/16	—	0.9375	— 23.812
	29/64	0.453125	— 11.509	61/64	0.953125	— 24.209	
	15/32	0.46875	— 11.906	31/32	—	0.96875	— 24.606
	31/64	0.484375	— 12.303	63/64	0.984375	— 25.003	
1/2	—	0.5000	— 12.700	1	—	1.000	— 25.400
	1 mm = 0.03937 in.			0.001 in. = 0.0254 mm			

U.S. to Metric Conversions

	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.9144
	Feet	Meters	0.3048
	Feet	Centimeters	30.48
	Inches	Meters	0.0254
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
Volume	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
Liquid Volume	Quarts	Liters	0.9463
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subtract 32°
			2. Multiply by 5/9

Torque Specifications

Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

These Torque Specifications for the installation and tightening of fasteners shall apply to all fasteners which do not have a specific requirement identified in this Service Manual. The following factors shall be considered when applying torque: cleanliness of the fastener, use of a thread sealant (e.g. Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature (e.g. Nylock nut), hardness of the surface underneath the fastener's head or similar condition which affects the installation.

As noted in the following tables, torque values should be **reduced by 25% for lubricated fasteners** to achieve the similar stress as a dry fastener. Torque values may also have to be reduced when the fastener is threaded into aluminum or brass. The specific torque value should be determined based on the aluminum or brass material strength, fastener size, length of thread engagement, etc.

The standard method of verifying torque shall be performed by marking a line on the fastener (head or nut) and mating part, then back off fastener 1/4 of a turn. Measure the torque required to tighten the fastener until the lines match up.

Fastener Identification

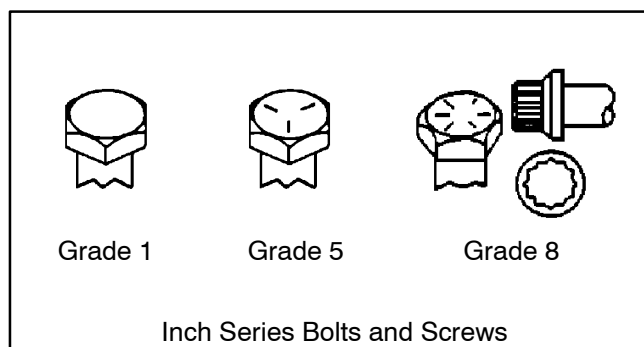


Figure 1

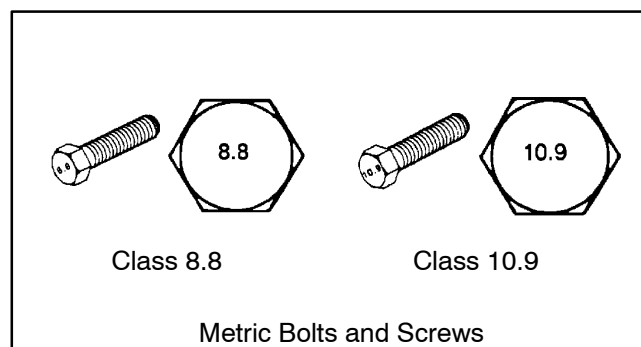


Figure 2

Using a Torque Wrench with an Offset Wrench

Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench calibration due to the effective change of torque wrench length. When using a torque wrench with an offset wrench, multiply the listed torque recommendation by the calculated torque conversion factor (Fig. 3) to determine proper tightening torque. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed torque recommendation.

Example: The measured effective length of the torque wrench (distance from the center of the handle to the center of the square drive) is 18".

The measured effective length of the torque wrench with the offset wrench installed (distance from the center of the handle to the center of the offset wrench) is 19".

The calculated torque conversion factor for this torque wrench with this offset wrench would be $18 / 19 = 0.947$.

If the listed torque recommendation for a fastener is from 76 to 94 ft-lb, the proper torque when using this torque wrench with an offset wrench would be from 72 to 89 ft-lb.

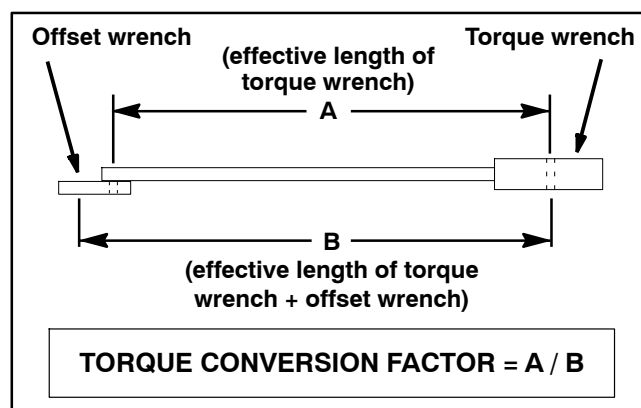


Figure 3

Standard Torque for Dry, Zinc Plated and Steel Fasteners (Inch Series)

Thread Size	Grade 1, 5 & 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 5 or Stronger Nuts)	
	in-lb	in-lb	N-cm	in-lb	N-cm	in-lb	N-cm
# 6 - 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	169 ± 23	23 ± 3	262 ± 34
# 6 - 40 UNF				17 ± 2	192 ± 23	25 ± 3	282 ± 34
# 8 - 32 UNC	13 ± 2	25 ± 5	282 ± 30	29 ± 3	328 ± 34	41 ± 5	463 ± 56
# 8 - 36 UNF				31 ± 4	350 ± 45	43 ± 5	486 ± 56
# 10 - 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 5	475 ± 56	60 ± 6	678 ± 68
# 10 - 32 UNF				48 ± 5	542 ± 56	68 ± 7	768 ± 79
1/4 - 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1130 ± 113	140 ± 15	1582 ± 169
1/4 - 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 12	1299 ± 136	160 ± 17	1808 ± 192
5/16 - 18 UNC	115 ± 15	105 ± 15	1186 ± 169	200 ± 25	2260 ± 282	300 ± 30	3390 ± 339
5/16 - 24 UNF	138 ± 17	128 ± 17	1446 ± 192	225 ± 25	2542 ± 282	325 ± 33	3672 ± 373
	ft-lb	ft-lb	N-m	ft-lb	N-m	ft-lb	N-m
3/8 - 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 5	58 ± 7
3/8 - 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 4	47 ± 5	50 ± 6	68 ± 8
7/16 - 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 - 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 6	75 ± 8	77 ± 8	104 ± 11
1/2 - 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 11	142 ± 15
1/2 - 20 UNF	32 ± 4	53 ± 7	72 ± 9	85 ± 9	115 ± 12	120 ± 12	163 ± 16
5/8 - 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 21	285 ± 28
5/8 - 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 18	230 ± 24	240 ± 24	325 ± 33
3/4 - 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 27	359 ± 37	375 ± 38	508 ± 52
3/4 - 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 30	407 ± 41	420 ± 43	569 ± 58
7/8 - 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 - 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 48	644 ± 65	667 ± 66	904 ± 89

NOTE: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as engine oil or thread sealant such as Loctite.

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

NOTE: The nominal torque values listed above for Grade 5 and 8 fasteners are based on 75% of the minimum proof load specified in SAE J429. The tolerance is approximately ± 10% of the nominal torque value. Thin height nuts include jam nuts.

Standard Torque for Dry, Zinc Plated and Steel Fasteners (Metric Series)

Thread Size	Class 8.8 Bolts, Screws and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 6 in-lb	644 ± 68 N-cm	78 ± 8 in-lb	881 ± 90 N-cm
M6 X 1.0	96 ± 10 in-lb	1085 ± 113 N-cm	133 ± 14 in-lb	1503 ± 158 N-cm
M8 X 1.25	19 ± 2 ft-lb	26 ± 3 N-m	28 ± 3 ft-lb	38 ± 4 N-m
M10 X 1.5	38 ± 4 ft-lb	52 ± 5 N-m	54 ± 6 ft-lb	73 ± 8 N-m
M12 X 1.75	66 ± 7 ft-lb	90 ± 10 N-m	93 ± 10 ft-lb	126 ± 14 N-m
M16 X 2.0	166 ± 17 ft-lb	225 ± 23 N-m	229 ± 23 ft-lb	310 ± 31 N-m
M20 X 2.5	325 ± 33 ft-lb	440 ± 45 N-m	450 ± 46 ft-lb	610 ± 62 N-m

NOTE: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as engine oil or thread sealant such as Loctite.

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

NOTE: The nominal torque values listed above are based on 75% of the minimum proof load specified in SAE J1199. The tolerance is approximately ± 10% of the nominal torque value.

Other Torque Specifications

SAE Grade 8 Steel Set Screws

Thread Size	Recommended Torque	
	Square Head	Hex Socket
1/4 - 20 UNC	140 ± 20 in-lb	73 ± 12 in-lb
5/16 - 18 UNC	215 ± 35 in-lb	145 ± 20 in-lb
3/8 - 16 UNC	35 ± 10 ft-lb	18 ± 3 ft-lb
1/2 - 13 UNC	75 ± 15 ft-lb	50 ± 10 ft-lb

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque**	
7/16 - 20 UNF Grade 5	65 ± 10 ft-lb	88 ± 14 N-m
1/2 - 20 UNF Grade 5	80 ± 10 ft-lb	108 ± 14 N-m
M12 X 1.25 Class 8.8	80 ± 10 ft-lb	108 ± 14 N-m
M12 X 1.5 Class 8.8	80 ± 10 ft-lb	108 ± 14 N-m

** For steel wheels and non-lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

Type 1, Type 23 or Type F	
Thread Size	Baseline Torque*
No. 6 - 32 UNC	20 ± 5 in-lb
No. 8 - 32 UNC	30 ± 5 in-lb
No. 10 - 24 UNC	38 ± 7 in-lb
1/4 - 20 UNC	85 ± 15 in-lb
5/16 - 18 UNC	110 ± 20 in-lb
3/8 - 16 UNC	200 ± 100 in-lb

Thread Cutting Screws (Zinc Plated Steel)

Thread Size	Threads per Inch		Baseline Torque*
	Type A	Type B	
No. 6	18	20	20 ± 5 in-lb
No. 8	15	18	30 ± 5 in-lb
No. 10	12	16	38 ± 7 in-lb
No. 12	11	14	85 ± 15 in-lb

* Hole size, material strength, material thickness and finish must be considered when determining specific torque values. All torque values are based on non-lubricated fasteners.

Conversion Factors

$$\text{in-lb} \times 11.2985 = \text{N-cm}$$

$$\text{ft-lb} \times 1.3558 = \text{N-m}$$

$$\text{N-cm} \times 0.08851 = \text{in-lb}$$

$$\text{N-m} \times 0.7376 = \text{ft-lb}$$



Kubota Diesel Engine

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KUBOTA WORKSHOP MANUAL, DIESEL ENGINE,
05- E4B SERIES

Kubota Diesel
Engine

Specifications

Item	Description
Make / Designation	Kubota Model D1105- E4B: 4- Cycle, 3 Cylinder, Water Cooled, Tier 4 Diesel Engine
Number of Cylinders	3
Bore x Stroke	3.07" x 3.09" (78 mm x 78.4 mm)
Total Displacement	68.5 in ³ (1123 cc)
Firing Order	1 (fan end) - 2 - 3 (flywheel end)
Direction of Rotation	Counterclockwise (viewed from flywheel)
Fuel	Diesel or Biodiesel (up to B20) Fuel with Low or Ultra Low Sulfur Content
Fuel Injection Pump	Bosch MD Type Mini Pump
Injection Nozzles	Mini Nozzle (DNOVD)
Fuel Tank Capacity	14 U.S. Gallons (53 Liters)
Governor	All Speed Mechanical
Low Idle Speed (no load)	1400 RPM
High Idle Speed (no load)	3000 RPM
Engine Oil	API CH- 4, CI- 4 or higher
Engine Oil Viscosity	See Traction Unit Operator's Manual
Oil Pump	Gear Driven Trochoid Type
Crankcase Oil Capacity	3.5 U.S. Quarts (3.3 Liters) with Filter
Cooling System Capacity (including reserve tank)	5.5 U.S. Quarts (5.2 Liters)
Starter	12 VDC 1.4 KW
Alternator/Regulator	12 VDC 40 Amp
Dry Weight (approximate)	205 lb. (93 kg)

NOTE: The Kubota engine used in your Reelmaster is equipped with a mechanical governor as listed above. During normal machine operation however, engine speed control is electronically managed by the machine TEC controller, the 48 VDC motor/generator controller and the engine mounted fuel actuator. These three (3) machine components determine engine/generator speed during use and modify fuel settings at the fuel actuator as necessary to maintain appropriate engine speed based on load.

General Information

This Chapter gives information about specifications, troubleshooting, testing and repair of the Kubota diesel engine used in Reelmaster 5010- H machines.

Most repairs and adjustments require tools which are commonly available in many service shops. The use of some specialized test equipment is explained in the engine Kubota Workshop Manual included at the end of this chapter. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

Service and repair parts for Kubota diesel engines are supplied through your local Toro Distributor. If an engine parts list is not available, be sure to provide your distributor with the Toro model and serial number.

Traction Unit Operator's Manual


The Traction Unit Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for the Kubota diesel engine that powers your Reelmaster machine. The Kubota Operator's Manual includes information specific to the engine used in your Reelmaster. Refer to these publications for additional information when servicing the machine.

Kubota Workshop Manual

The engine that powers your Reelmaster machine is a Kubota model D1105- E4B (Tier 4 compliant). The Kubota Workshop Manual, Diesel Engine, 05- E4B Series is available for this engine. Make sure that the correct engine manual is used when servicing the engine on your Reelmaster.

Kubota Diesel Engine

48 VDC Battery Disconnect

**CAUTION**

Before installing, removing or servicing components in the 48 VDC system (e.g. cutting unit motors, motor/generator), separate the 48 VDC battery disconnect. This will prevent unexpected operation of 48 VDC system components.

The 48 VDC battery disconnect is attached to the right frame rail under the operator seat (Fig. 1). Unplug the disconnect to make sure that 48 VDC components do not operate unexpectedly. Apply dielectric grease to the contact surfaces of the battery disconnect and plug the battery disconnect back in after service to the 48 VDC system is completed.

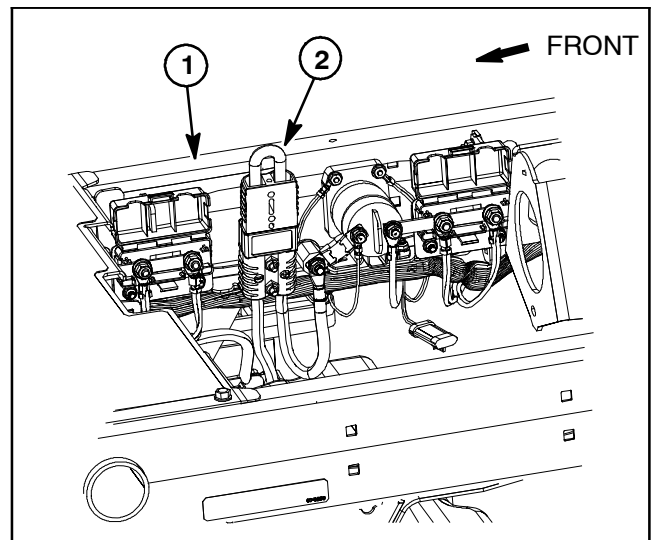


Figure 1

- 1. RH frame rail
- 2. 48V battery disconnect

Service and Repairs

Air Cleaner Assembly

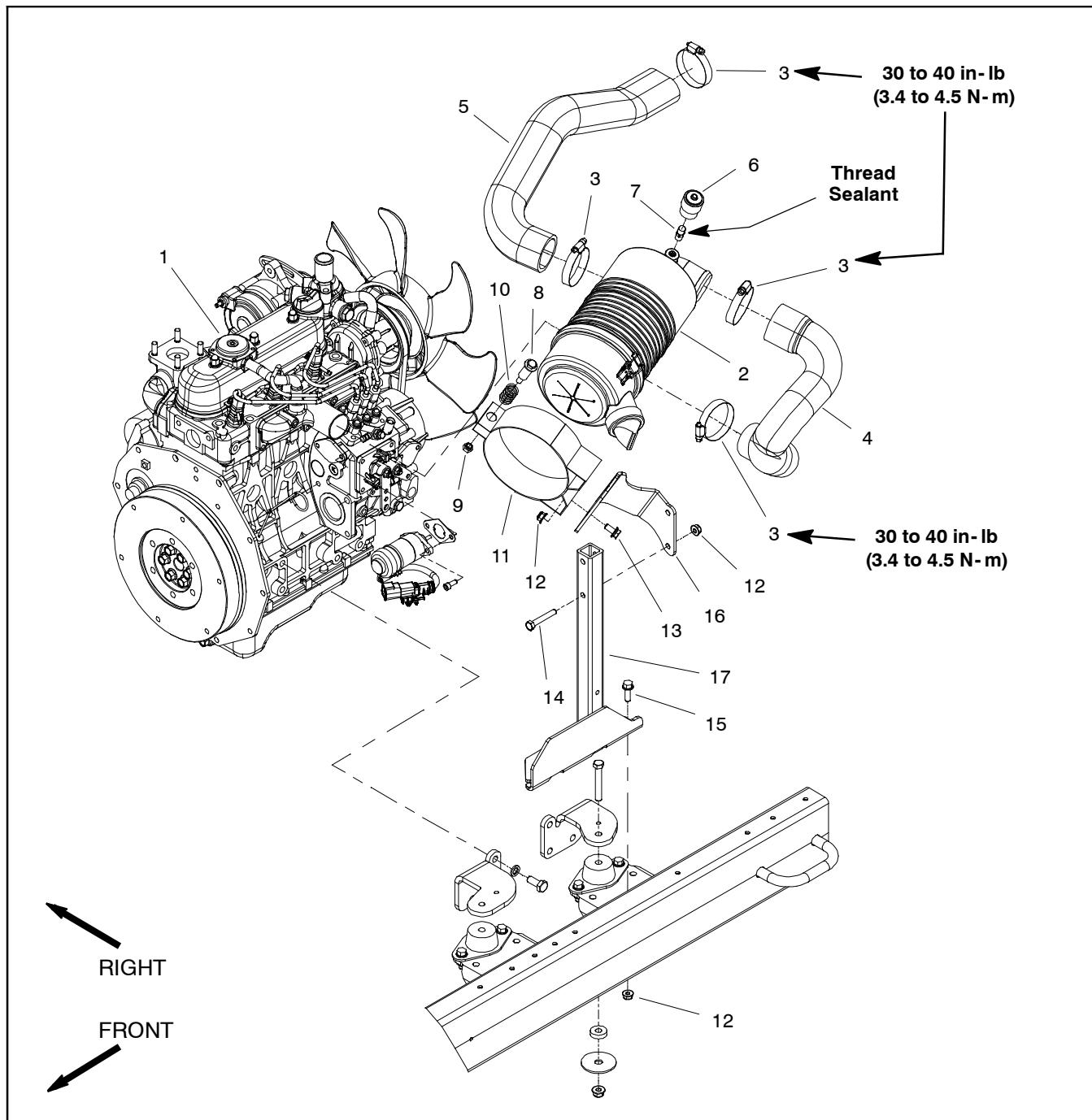


Figure 2

- | | | |
|-------------------------|-------------------------------|--------------------------------|
| 1. Diesel engine | 7. Indicator adapter | 13. Flange head screw (2 used) |
| 2. Air cleaner assembly | 8. Shoulder bolt | 14. Cap screw (2 used) |
| 3. Hose clamp (4 used) | 9. Nut | 15. Flange head screw (2 used) |
| 4. Air intake hose | 10. Compression spring | 16. Air cleaner bracket |
| 5. Air intake hose | 11. Air cleaner mounting band | 17. Air cleaner stand |
| 6. Service indicator | 12. Flange nut (6 used) | |

Removal (Fig. 2)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch. Raise and support hood.
2. Remove air cleaner components as needed using Figure 2 as a guide.
3. See Traction Unit Operator's Manual for air cleaner service and maintenance procedures.

Installation (Fig. 2)

IMPORTANT: Any leaks in the air filter system will allow dirt into engine and will cause serious engine damage. Make sure that all air cleaner components are in good condition and are properly secured during assembly.

1. Assemble air cleaner system using Figure 2 as a guide.

A. If service indicator (item 6 in Fig. 2) and adapter (item 7 in Fig. 2) were removed from air cleaner housing, apply thread sealant to adapter threads before installing adapter and indicator to housing. Install adapter so that grooves in adapter hex and adapter filter element are installed toward service indicator (shown in Fig. 3). Torque indicator from **12 to 15 in-lb (1.4 to 1.6 N-m)**.

B. Make sure that evacuator valve on air cleaner assembly is pointed down after assembly.

C. Torque hose clamps from **30 to 40 in-lb (3.4 to 4.5 N-m)**.

2. After air cleaner has been properly installed, lower and secure hood.

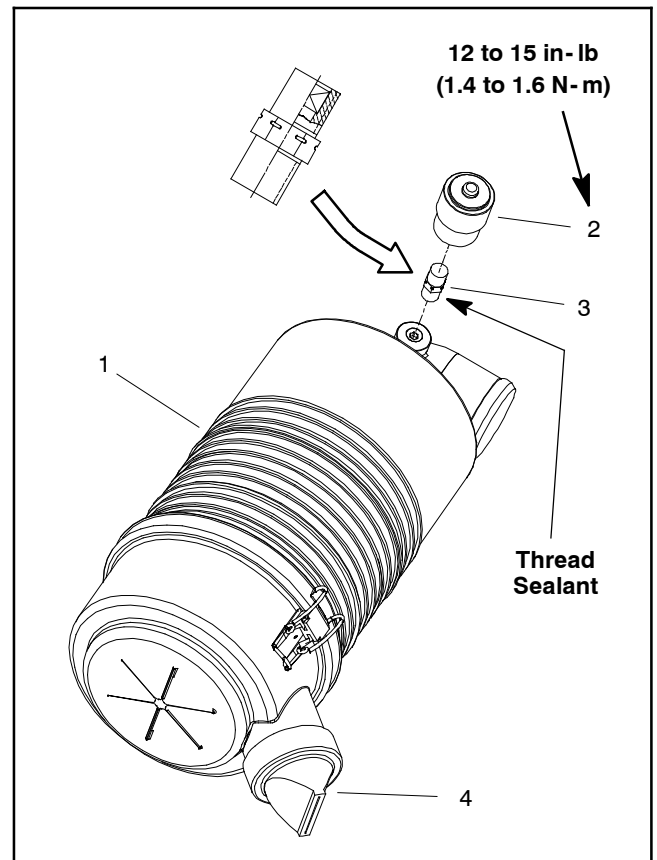


Figure 3

- | | |
|-------------------------|----------------------|
| 1. Air cleaner assembly | 3. Indicator adapter |
| 2. Service indicator | 4. Evacuator valve |

Exhaust System

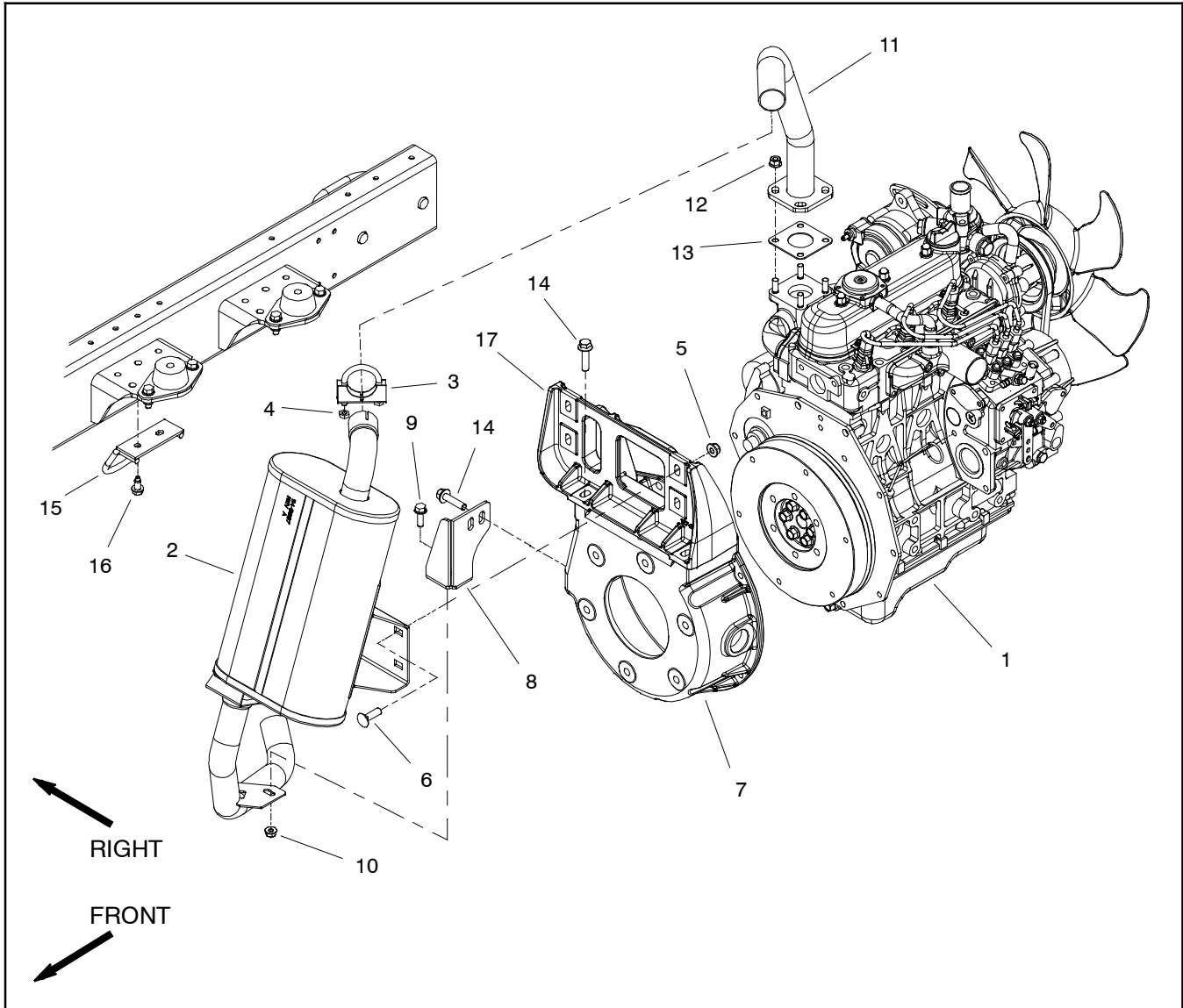



Figure 4

- | | | |
|---------------------------|-------------------------|--------------------------------|
| 1. Diesel engine | 7. Bellhousing | 13. Exhaust gasket |
| 2. Exhaust muffler | 8. Tailpipe bracket | 14. Flange head screw (6 used) |
| 3. Clamp | 9. Flange head screw | 15. Muffler guard |
| 4. Hex nut (2 used) | 10. Flange nut | 16. Washer head screw (2 used) |
| 5. Flange nut (4 used) | 11. Exhaust header | 17. Muffler bracket |
| 6. Carriage bolt (4 used) | 12. Flange nut (4 used) | |

Removal (Fig. 4)

	CAUTION
The muffler and exhaust pipe may be hot. To avoid possible burns, allow the engine and exhaust system to cool before working on the exhaust system.	

1. Raise and support hood to gain access to exhaust system. Allow engine and exhaust system to cool before doing any disassembly of exhaust system components.
2. Remove exhaust system components from the engine as necessary using Figure 4 as a guide. Discard exhaust gasket (item 13) if exhaust header (item 11) was removed.

Installation (Fig. 4)

IMPORTANT: If exhaust studs were removed from engine cylinder head, thoroughly clean threads in head and apply Loctite #277 (or equivalent) to stud threads before installing studs into head.

NOTE: Make sure that all exhaust system flanges and sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Install **new** exhaust gasket (item 13) if gasket was removed. Do not use any type of gasket sealant on gasket or flange surfaces.
2. Install all removed exhaust system components using Figure 4 as a guide. Hand tighten exhaust system fasteners and after all exhaust system components have been installed, fully tighten the fasteners as shown in Figure 5:

- A. Tighten flange head screws that secure muffler bracket to engine bellhousing.
- B. Tighten carriage screws and flange nuts that secure exhaust muffler to muffler bracket.
- C. Tighten flange nuts that secure exhaust header to engine exhaust manifold.
- D. Tighten clamp that secures exhaust muffler to exhaust header.
- E. Tighten flange head screw and flange nut that secures exhaust muffler to tailpipe bracket.
- F. Tighten flange head screws that secure tailpipe bracket to engine bellhousing.

3. Adjust muffler guard (item 15) on frame so there is $\frac{3}{8}$ " (9.5 mm) clearance between exhaust tailpipe and guard in all directions.

4. After all exhaust components have been installed, lower and secure hood.

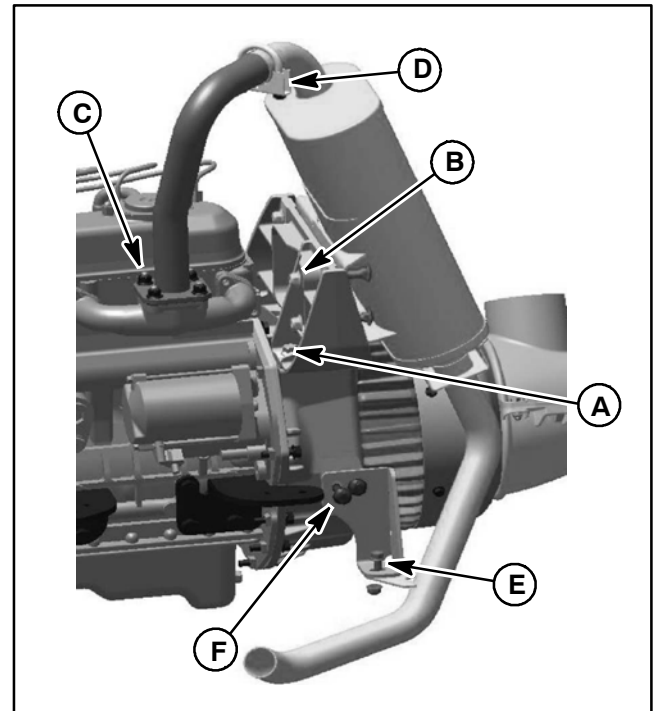


Figure 5

Fuel System

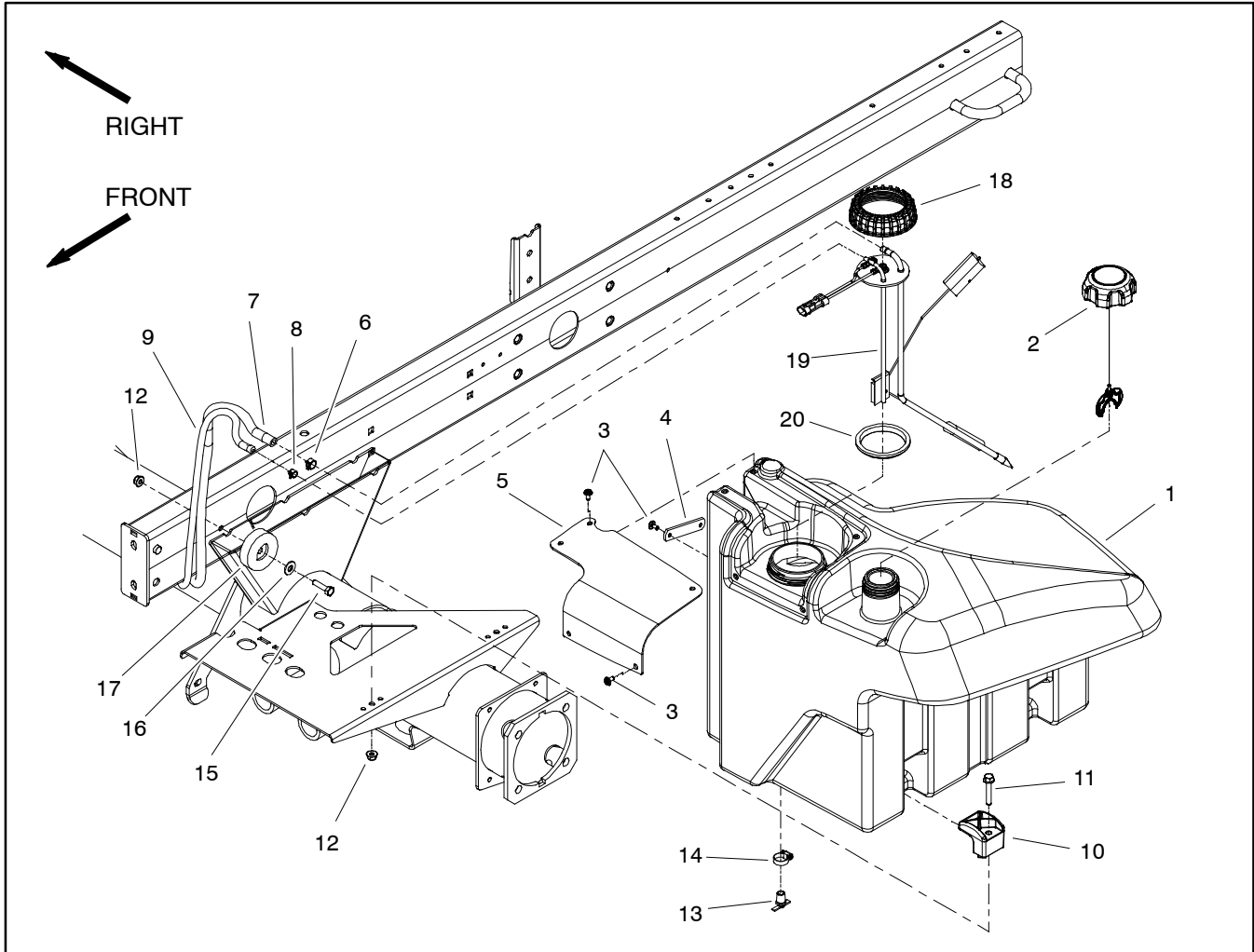


Figure 6

- | | | |
|---------------------|--------------------------------|---------------------|
| 1. Fuel tank | 8. Hose clamp | 15. Cap screw |
| 2. Fuel tank cap | 9. Fuel return hose | 16. Flat washer |
| 3. Screw (7 used) | 10. Clamp (2 used) | 17. Bumper |
| 4. Strap | 11. Flange head screw (2 used) | 18. Fuel sender cap |
| 5. Sender cover | 12. Flange nut (3 used) | 19. Fuel sender |
| 6. Hose clamp | 13. Draincock | 20. Gasket |
| 7. Fuel supply hose | 14. Hose clamp | |



DANGER

Because diesel fuel is flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, when engine is hot or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety-approved container and keep container cap in place. Use diesel fuel for the engine only; not for any other purpose.

Check Fuel Lines and Connections

Check fuel lines and connections periodically as recommended in the Traction Unit Operator's Manual. Check lines for deterioration, damage, leakage or loose connections. Replace fuel hoses, clamps and connections as necessary.

Drain and Clean Fuel Tank

Drain and clean the fuel tank periodically as recommended in the Traction Unit Operator's Manual. Also, drain and clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

IMPORTANT: Follow all local codes and regulations when recycling or disposing waste fuel.

To clean fuel tank, flush tank out with clean diesel fuel. Make sure tank is free of all contaminates and debris.

Priming the Fuel System

The fuel system needs to be primed before starting the engine for the first time, after running out of fuel or after fuel system maintenance (e.g. draining the filter/water separator, replacing a fuel hose). To prime the fuel system, make sure that the fuel tank has fuel in it. Then, turn the ignition key to the RUN position for ten (10) to fifteen (15) seconds which allows the fuel pump to prime the fuel system. **DO NOT** use the engine starter motor to crank the engine in order to prime the fuel system.

Fuel Tank Removal (Fig. 6)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.
2. Place drain pan under fuel tank. Make sure that drain pan is large enough to hold fuel tank contents (see Specifications in this chapter).
3. Open draincock on bottom of fuel tank and allow tank to fully drain. Close draincock.
4. Disconnect wire harness connection from the fuel sender (item 19).

NOTE: Before removing fuel hoses from tank fittings, label hoses for assembly purposes.

IMPORTANT: To prevent damage to fuel hoses, numerous cable ties are used to secure hoses to machine components. Take note of all cable ties that are removed from machine during fuel tank removal so they can be properly replaced during tank installation.

5. Loosen hose clamps and carefully disconnect supply (item 7) and return (item 9) fuel hoses from fittings on the top of the fuel sender.
6. Remove fuel tank using Figure 6 as a guide.

IMPORTANT: If fuel sender is removed from fuel tank, note orientation of fittings for assembly purposes (Fig. 7).

Fuel Tank Installation (Fig. 6)

1. Install fuel tank to frame using Figure 6 as a guide. Secure fuel hoses with cable ties as noted during fuel tank removal.
 - A. If fuel sender was removed from fuel tank, make sure that fuel fittings on sender are orientated at 90° from right side of tank as shown in Figure 7. Also, to prevent damage to fuel sender during assembly, make sure that fuel sender does not turn as sender cap is tightened.
2. Correctly connect supply (item 7) and return (item 9) fuel hoses to fittings on the top of the fuel sender. Secure fuel hoses with hose clamps.
3. Secure wire harness connector to fuel sender.
4. Make sure that fuel tank draincock is closed. Fill fuel tank with clean fuel.
5. Prime the fuel system (see above).
6. Before returning machine to operation, make sure that no fuel leaks exist.

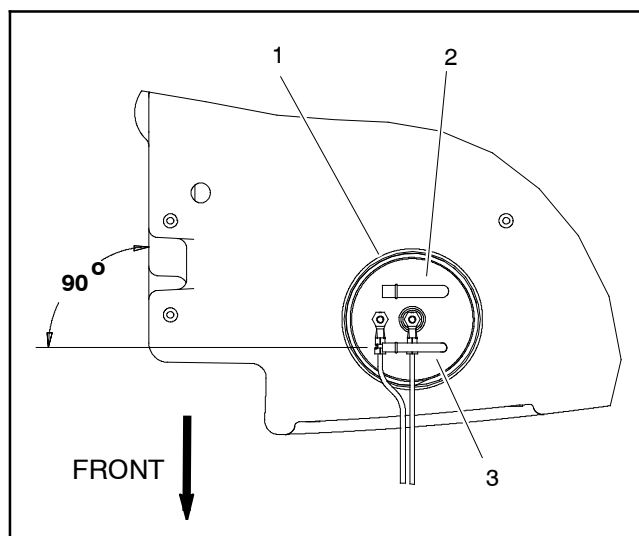


Figure 7

- | | |
|------------------------|------------------------|
| 1. Fuel sender | 3. Fuel return fitting |
| 2. Fuel supply fitting | |

Radiator Assembly

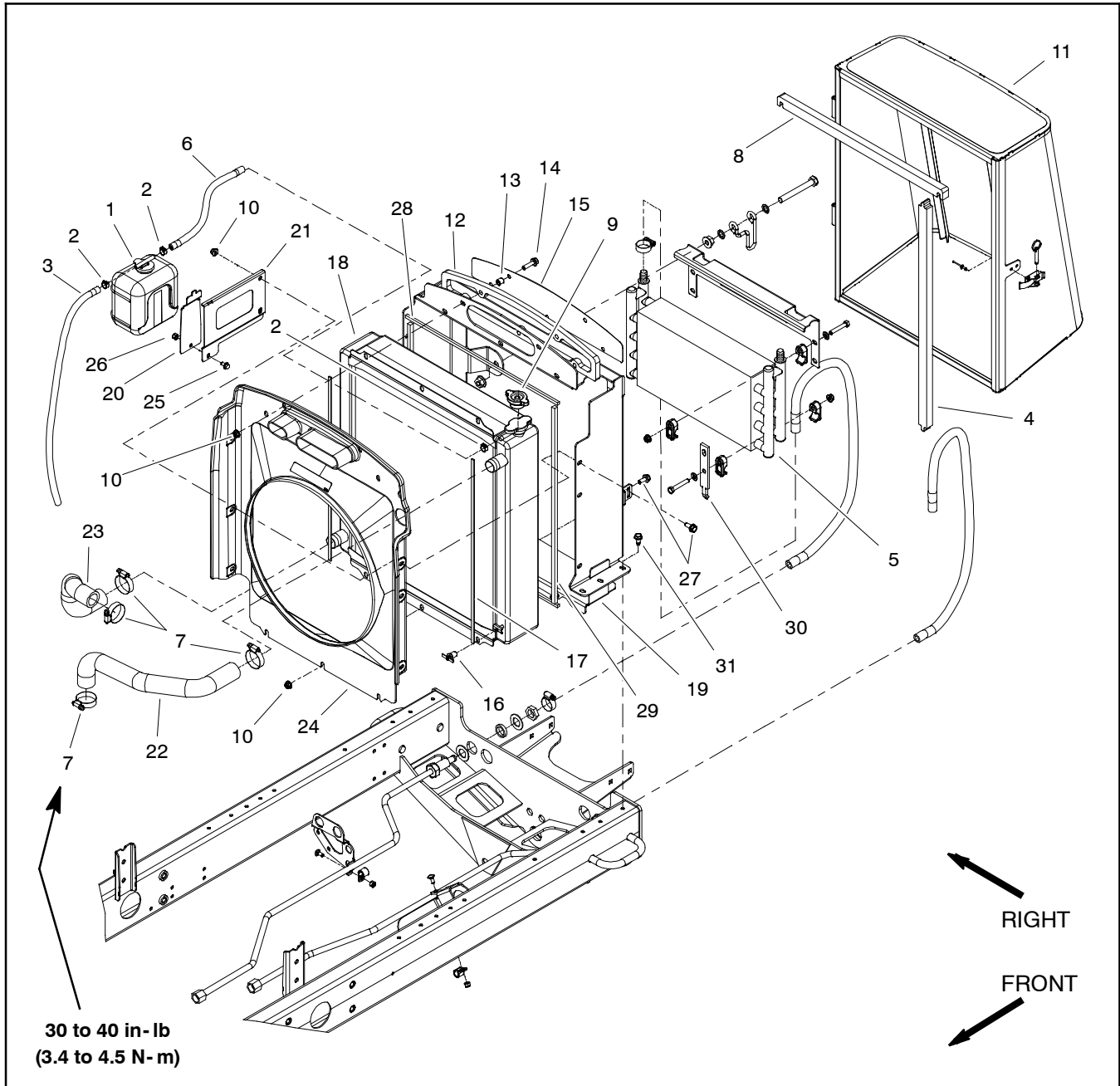



Figure 8

- | | | |
|--------------------------|--------------------------------|--------------------------------|
| 1. Coolant reservoir | 12. Foam seal | 22. Upper radiator hose |
| 2. Hose clamp (3 used) | 13. Spacer (5 used) | 23. Lower radiator hose |
| 3. Hose | 14. Flange head screw (5 used) | 24. Fan shroud |
| 4. Foam seal (2 used) | 15. Air intake screen | 25. Flange head screw |
| 5. Oil cooler | 16. Draincock | 26. Lock nut |
| 6. Hose | 17. Foam seal (2 used) | 27. Flange head screw (9 used) |
| 7. Hose clamp (4 used) | 18. Radiator | 28. Foam seal (2 used) |
| 8. Foam seal (2 used) | 19. Radiator frame | 29. Foam seal (2 used) |
| 9. Radiator cap | 20. Reservoir bracket | 30. Mount plate (2 used) |
| 10. Flange nut (14 used) | 21. Reservoir bracket | 31. Washer head screw (6 used) |
| 11. Rear screen | | |

Removal (Fig. 8)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.
2. Unlatch rear screen, lift screen from hinges and remove screen from machine.
3. Remove 12 volt battery from rear of machine to ease oil cooler removal (see 12 VDC Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).
4. Rotate clamps that secure oil cooler to radiator frame. Carefully lift and remove oil cooler from radiator frame. Position and support oil cooler away from the radiator.
5. Raise and support the hood.

**CAUTION**

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

6. Drain radiator into a suitable container either by using the draincock (item 16) on the left side of the radiator or by disconnecting the lower radiator hose from the radiator. Make sure that drain container is large enough to hold cooling system contents (see Specifications in this Chapter).

IMPORTANT: Follow all local codes and regulations when recycling or disposing engine coolant.

7. Disconnect air cleaner and motor/generator intake hoses from fan shroud (Fig. 9).
8. Disconnect radiator hoses (upper and lower) from the radiator.
9. At rear of radiator frame, carefully cut the upright foam seals (item 4) at the junction of the radiator frame and the machine frame. This will allow the radiator frame to be removed from the machine without removing the foam seal from the radiator and machine frames.
10. Remove six (6) washer head screws (item 31) that secure the radiator frame (item 19) to the frame.
11. Carefully raise radiator assembly (radiator, fan shroud, coolant reservoir and radiator frame) from the machine.

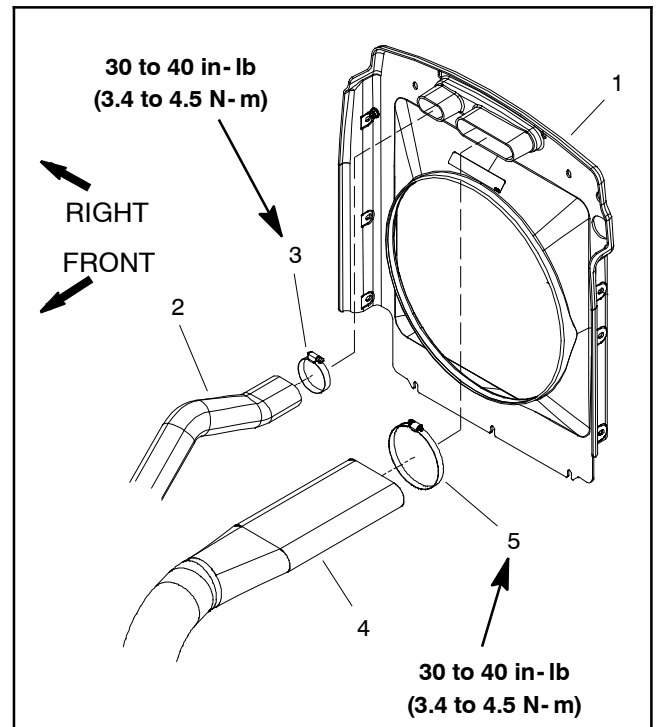


Figure 9

- | | |
|----------------------------|--------------------------|
| 1. Fan shroud | 4. Generator intake hose |
| 2. Air cleaner intake hose | 5. Hose clamp |
| 3. Hose clamp | |

12. Plug radiator and hose openings to prevent contamination.

13. Disassemble radiator assembly as needed using Figure 8 as a guide.

Installation (Fig. 8)

1. Inspect all foam seals placed between radiator, fan shroud and radiator frame. Replace damaged foam seals.
2. Remove plugs placed in radiator and hose openings during the removal procedure.
3. Install all removed components to radiator frame using Figure 8 as a guide.
4. Carefully lower radiator assembly with radiator, fan shroud, coolant reservoir and radiator frame to the machine frame.
5. Secure the radiator frame (item 19) to the frame with six (6) washer head screws (item 31).
6. Make sure that at least 0.250" (6.4 mm) clearance exists at all points between fan shroud opening and fan.
7. Connect upper and lower radiator hoses to radiator and secure with hose clamps. Torque hose clamps from **30 to 40 in-lb (3.4 to 4.5 N-m)**.

8. Connect air cleaner and motor/generator intake hoses to fan shroud and secure with hose clamps (Fig. 9). Torque hose clamps from **30 to 40 in-lb (3.4 to 4.5 N-m)**.
9. Make sure radiator draincock is closed (threaded out fully).
10. Fill radiator and coolant reservoir with coolant.
11. Lower and secure hood.

12. Carefully position and install oil cooler to radiator frame. Rotate clamps to secure oil cooler to radiator frame.

13. Install 12 volt battery (see 12 VDC Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).

14. Install and latch rear screen.

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Engine

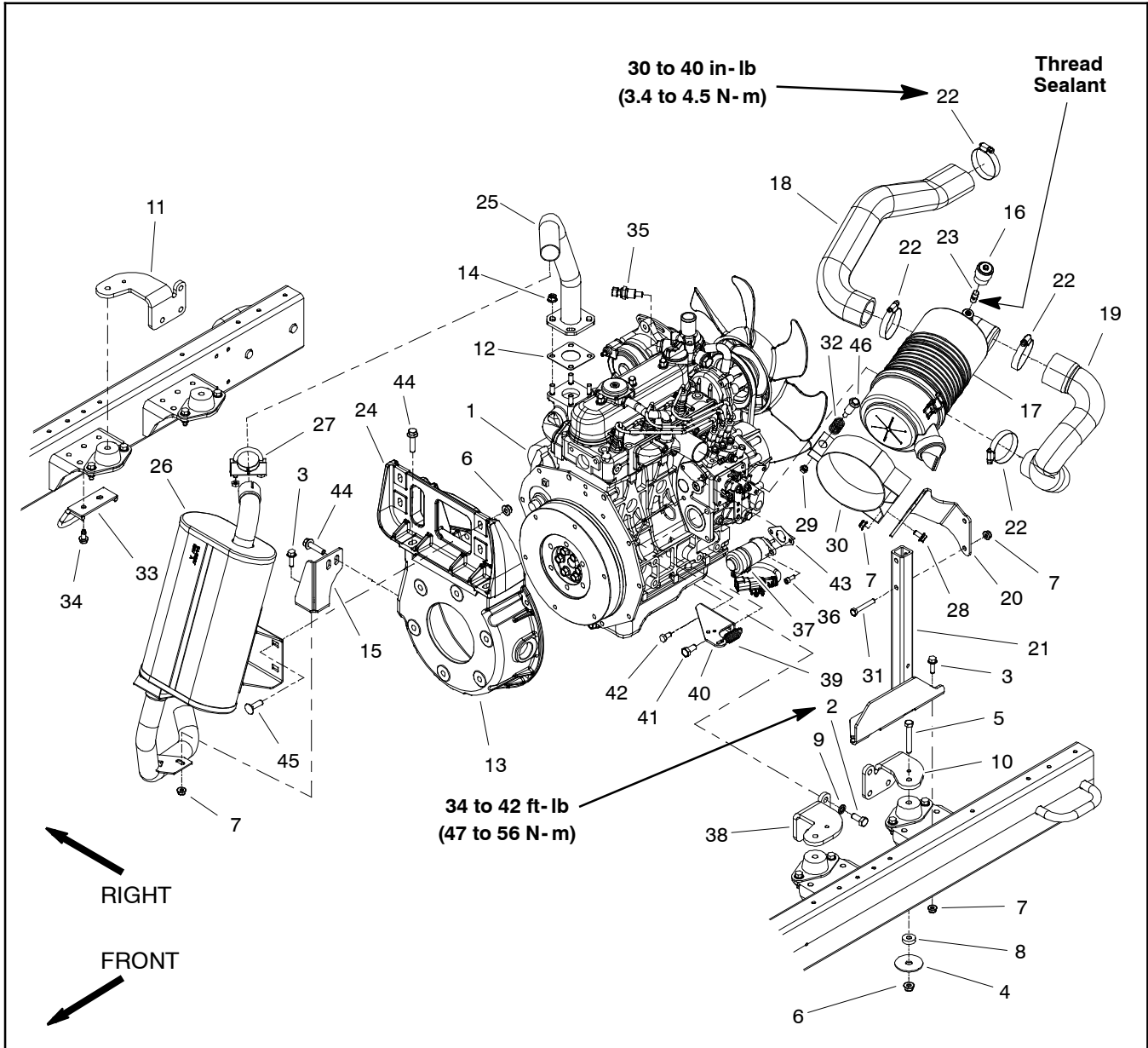


Figure 10

- | | | |
|-------------------------------|--------------------------------|--------------------------------|
| 1. Diesel engine | 17. Air cleaner assembly | 32. Compression spring |
| 2. Cap screw (12 used) | 18. Air intake hose | 33. Muffler guard |
| 3. Flange head screw (4 used) | 19. Air intake hose | 34. Washer head screw (2 used) |
| 4. Snubbing washer (4 used) | 20. Air cleaner bracket | 35. Temperature sender |
| 5. Cap screw (4 used) | 21. Air cleaner stand | 36. Socket head screw (2 used) |
| 6. Flange nut (8 used) | 22. Hose clamp (4 used) | 37. Fuel actuator |
| 7. Flange nut (8 used) | 23. Indicator adapter | 38. LH engine mount |
| 8. Spacer (4 used) | 24. Muffler bracket | 39. Extension spring |
| 9. Lock washer (12 used) | 25. Exhaust header | 40. Throttle spring bracket |
| 10. Engine mount (2 used) | 26. Exhaust muffler | 41. Cap screw |
| 11. RH engine mount | 27. Clamp | 42. Cap screw |
| 12. Exhaust gasket | 28. Flange head screw (2 used) | 43. Fuel actuator gasket |
| 13. Bellhousing | 29. Nut | 44. Flange head screw (6 used) |
| 14. Flange nut (4 used) | 30. Air cleaner mounting band | 45. Carriage bolt (4 used) |
| 15. Tailpipe bracket | 31. Cap screw (2 used) | 46. Shoulder bolt |

Engine Removal (Fig. 10)

1. Park machine on a level surface, lower cutting units, stop engine and remove key from the ignition switch. Chock wheels to keep the machine from moving.


2. Disconnect negative (-) and then positive (+) battery cables from the 12 volt battery at the rear of the machine (see 12 VDC Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).

3. Open and support hood.

4. Separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect. (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected 48 VDC system component operation.

5. Remove air cleaner from machine (see Air Cleaner Assembly in this section).

6. Remove exhaust muffler from machine (see Exhaust System in this section).



CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

7. Drain radiator into a suitable container either by using the draincock on the left side of the radiator or by disconnecting the lower radiator hose from the radiator. Make sure that drain container is large enough to hold cooling system contents (see Specifications in this Chapter).

IMPORTANT: Follow all local codes and regulations when recycling or disposing engine coolant.

8. Disconnect hoses from engine:

A. Loosen clamps and remove upper and lower radiator hoses from the engine.

B. Disconnect fuel supply and return hoses from engine (Fig. 11).

C. Plug disconnected hoses and engine openings to prevent leakage and contamination. Position disconnected hoses away from engine.

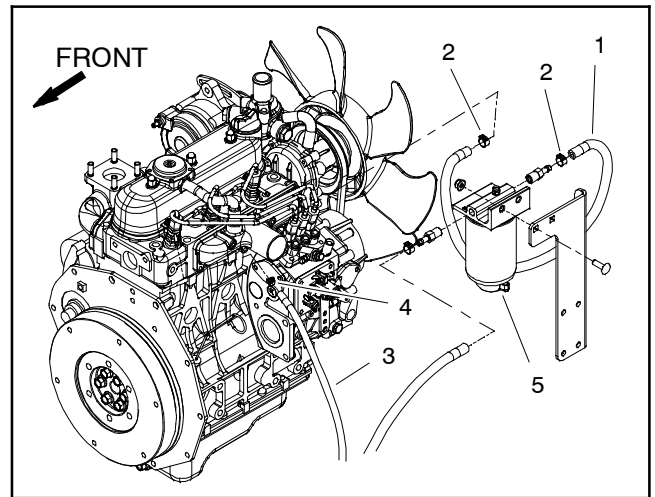


Figure 11

- | | |
|---------------------|---------------|
| 1. Fuel supply hose | 4. Hose clamp |
| 2. Hose clamp | 5. Separator |
| 3. Fuel return hose | |

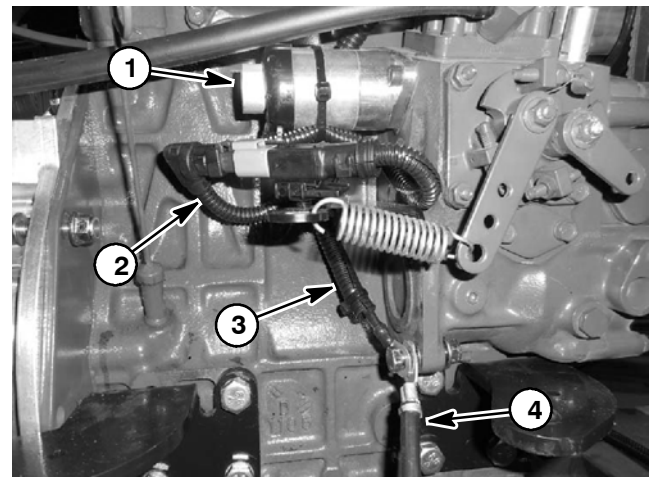


Figure 12

- | | |
|----------------------------|---------------------------|
| 1. Fuel actuator | 3. Wire harness ground |
| 2. Fuel actuator connector | 4. Negative battery cable |

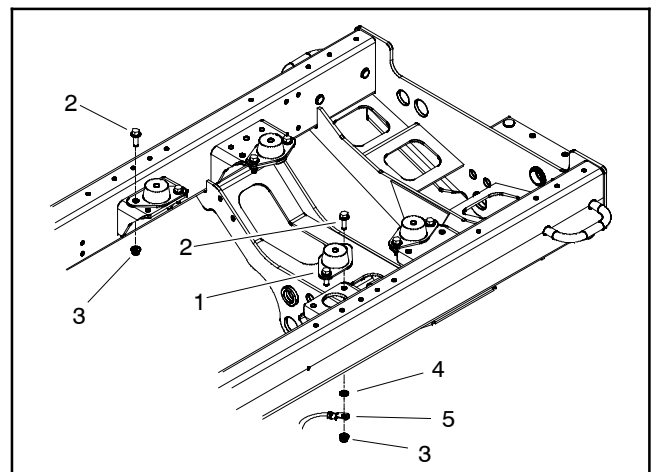


Figure 13

- | | |
|--------------------------|-----------------|
| 1. Engine mount (4 used) | 4. Lock washer |
| 2. Screw (2 per mount) | 5. Ground cable |
| 3. Nut (2 per mount) | |

9. Disconnect hydraulic pump drive shaft from 48 VDC motor/generator (see Hydraulic Pump Drive Shaft in the Service and Repairs section of Chapter 4 - Hydraulic System). Position and support drive shaft away from motor/generator and engine.

IMPORTANT: To prevent damage to electrical wire harness, numerous cable ties are used to secure harness to machine components. Take note of all cable ties that are removed from machine during engine removal so they can be properly replaced during engine installation.


10. Note location of cable ties used to secure wire harness to the machine for assembly purposes. Disconnect wires and/or electrical connections from the following engine electrical components:

- A. The wire harness connectors from the alternator, temperature sender, oil pressure switch, starter motor solenoid and fuel actuator.
- B. The wire harness ring terminals from the alternator and glow plug bus.
- C. The positive battery cable and fusible link harness from the engine starter motor.
- D. The negative battery cable and wire harness ground at the engine block under the fuel actuator (Fig. 12).
- E. The wire harness connector from the 48 VDC motor/generator assembly.

	CAUTION
Make sure that hoist or lift used to remove engine assembly can properly support engine and attached components. Engine assembly weighs approximately 280 pounds (127 kg).	

11. Connect suitable lift or hoist to the lift brackets on each end of the engine cylinder head.

12. Remove flange nuts, rebound washers, spacers and cap screws that secure the engine mount brackets to the engine mounts.

	CAUTION
One person should operate hoist or lift while a second person guides the engine out of the machine.	

IMPORTANT: Make sure to not damage the engine, fuel hoses, hydraulic lines, electrical harness, radiator or other parts while removing the engine.

13. Carefully raise engine from machine moving it toward the front of the machine and away from radiator assembly.

14. If necessary, remove engine mount brackets from engine.

15. If necessary, remove engine mounts from machine frame (Fig. 13). Note that front engine mount on left side of machine has the negative battery cable ground connection secured with one of the mount bolts. If removed, make sure to locate lock washer that should be installed between the cable connection and the frame.

16. If necessary, remove 48 VDC motor/generator from engine (see 48 VDC Motor/Generator Assembly in the Service and Repairs section of Chapter 5 - Electrical System).

Engine Installation (Fig. 10)

1. Locate machine on a level surface with cutting units lowered and key removed from the ignition switch. Chock wheels to keep the machine from moving.

2. Make sure that all parts removed from the engine during maintenance or rebuilding are installed to the engine.

3. If engine mount brackets were removed from the engine, secure brackets to engine with lock washers and cap screws. Torque cap screws from **34 to 42 ft-lb (47 to 56 N-m)**.

4. If removed, install 48 VDC motor/generator and bell-housing assembly to engine (see 48 VDC Motor/Generator Assembly in the Service and Repairs section of Chapter 5 - Electrical System).

5. If removed, secure engine mounts to frame machine frame (Fig. 13). Make sure that negative battery cable ground connection is secured with lock washer between the cable connection and the frame if front engine mount on left side of machine was removed.

6. Connect suitable lift or hoist to the engine lift brackets.



CAUTION

One person should operate lift or hoist while a second person guides the engine into the machine.

IMPORTANT: Make sure to not damage the engine, fuel hoses, hydraulic lines, electrical harness, radiator or other parts while installing the engine.

7. Carefully lower engine to the mounts secured to the machine frame. Make sure fastener holes of the engine mount brackets are aligned with the holes in the engine mounts.

8. Insert cap screw down through each engine mount bracket and mount. Place spacer, snubbing washer and then flange nut on four (4) cap screws. Tighten fasteners to secure engine to engine mounts.

9. Connect hydraulic pump drive shaft to motor/generator output shaft (see Hydraulic Pump Drive Shaft in the Service and Repairs section of Chapter 4 - Hydraulic System).

10. Connect all wire harness connectors to correct engine components. Secure wire harness to the machine with cable ties in locations noted during engine removal.

11. Remove plugs installed in fuel and coolant hoses and engine openings during disassembly. Connect hoses to the engine:

A. Connect fuel supply and fuel return hoses to engine fittings (Fig. 11). Secure fuel hoses with hose clamps.

B. Connect upper and lower radiator hoses to the engine. Secure hoses with hose clamps. Torque hose clamps from **30 to 40 in-lb (3.4 to 4.5 N-m)**.

12. Install air cleaner (see Air Cleaner Assembly in this section).

13. Install exhaust muffler to machine (see Exhaust System in this section). Make sure that exhaust tube has $\frac{3}{8}$ " (9.5 mm) clearance with guard in all directions after assembly.

14. Make sure radiator draincock is closed (threaded out fully). Fill radiator and coolant reservoir with coolant.

15. Check engine oil level and adjust if needed.

16. Check and adjust oil level in hydraulic reservoir as needed.

17. Plug the 48 VDC battery disconnect back in.

18. Close and secure hood.

19. Connect positive (+) and then negative (-) battery cables to the 12 volt battery (see 12 VDC Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).

20. Prime the fuel system (see Fuel System in this section).

21. Start engine and operate hydraulic controls to properly fill hydraulic system (see Charge Hydraulic System in the Service and Repairs section of Chapter 4 - Hydraulic System).

Engine Bellhousing Assembly

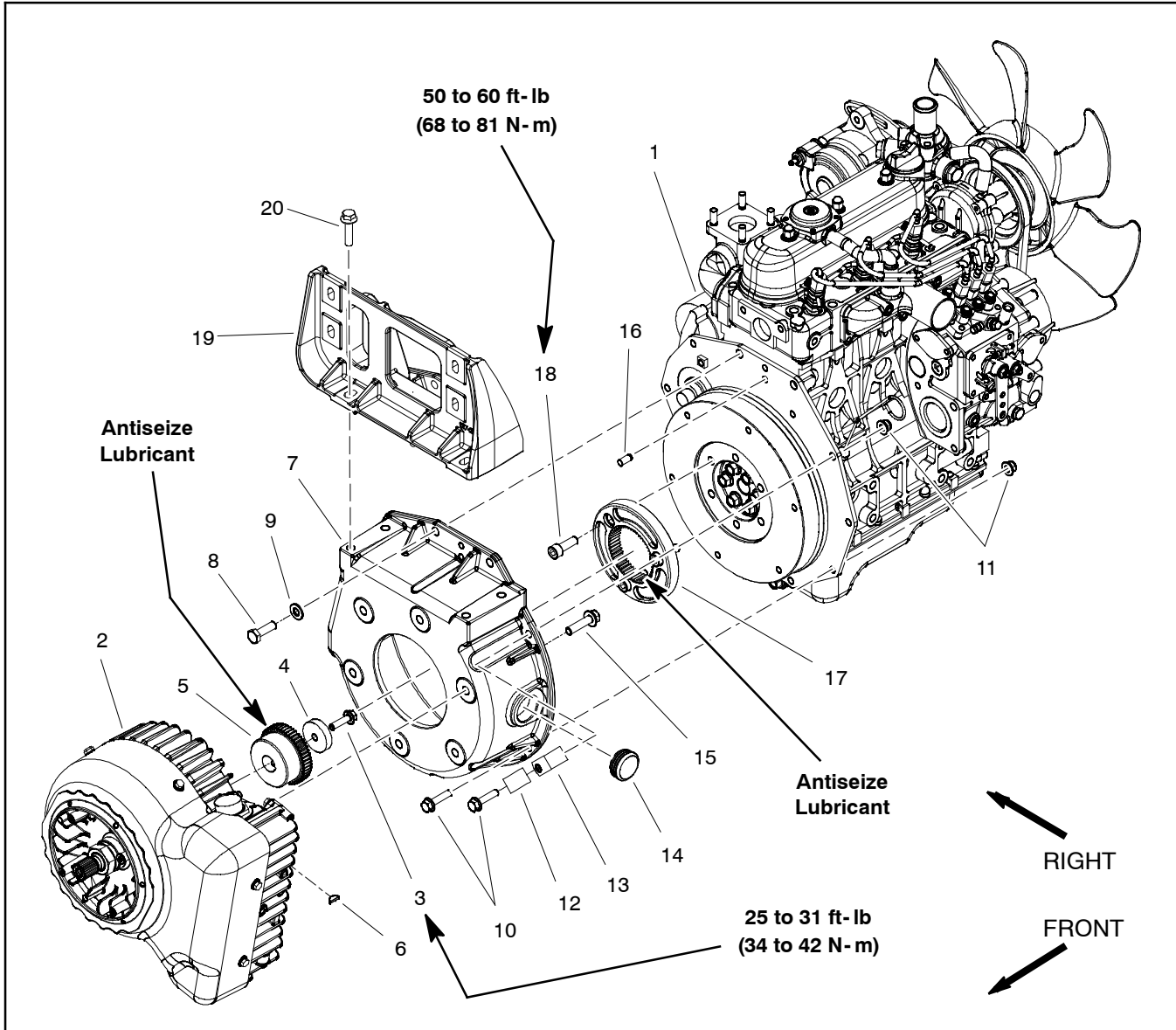


Figure 14

- | | | |
|-----------------------------|--|--------------------------------|
| 1. Diesel engine | 8. Cap screw (2 used) | 15. Flange head screw (6 used) |
| 2. Motor/generator assembly | 9. Flat washer (2 used) | 16. Dowel pin (2 used) |
| 3. Flange head screw | 10. Flange head screw (7 used) | 17. Coupler flange |
| 4. Collar | 11. Flange nut (2 used) | 18. Socket head screw (3 used) |
| 5. Coupler hub | 12. R-clamp (for generator wire harness) | 19. Muffer bracket |
| 6. Woodruff key | 13. Clamp (for fuel return hose) | 20. Flange head screw (4 used) |
| 7. Bellhousing | 14. Caplug | |

The 48 VDC motor/generator is attached to the engine bellhousing with six (6) flange head screws. Access to these screws requires the bellhousing and motor/generator to be removed from the engine as an assembly. For recommended procedures to remove the bellhousing and motor/generator assembly from the engine, see 48 VDC Motor/Generator Assembly in the Service and Repairs section of Chapter 5 - Electrical System.



Hydraulic System

Hydraulic System

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		EATON DELTA MOTORS PARTS AND REPAIR	
		MANUAL	
		PARKER TORQMOTOR™ SERVICE PROCEDURE	
		(TC, TB, TE, TJ, TF, TG, TH AND TL SERIES)	
		SAUER-DANFOSS STEERING UNIT TYPE OSPM	
		SERVICE MANUAL	

Specifications


Item	Description
Piston (Traction) Pump Maximum Pump Displacement (per revolution)	Closed Circuit Axial Piston Design 2.14 Cubic Inches (35 cc)
Gear Pump Section P1 Displacement (per revolution) (all models) Section P2 Displacement (per revolution) (all models)	2 Section, Positive Displacement Gear Type Pump 0.24 Cubic Inches (3.96 cc) 0.40 Cubic Inches (6.61 cc)
Charge Circuit Relief (R5) Pressure	200 PSI (14 bar)
Traction Circuit Relief Pressure: Forward (R3) and Reverse (R4)	3625 PSI (250 bar)
Front Wheel Motors Displacement (per revolution)	Geroler Motor 24.7 in ³ (405 cc)
Rear Wheel Motors (if equipped) Displacement (per revolution)	Rotor Motor 19.0 in ³ (310 cc)
Steering Valve Displacement (per revolution)	Hydrostatic Steering Unit, Open Center 6.1 in ³ (100 cc)
Steering Circuit Relief (R10) Pressure	1000 PSI (70 bar)
Lift Circuit Relief (SVRV) Pressure	2000 PSI (138 bar)
Lift Circuit Lower Relief (R7) Pressure	500 PSI (35 bar)
Hydraulic Filter (Steering Circuit)	Spin-on Cartridge Type with 25 PSI (1.7 bar) Relief in Adapter
Hydraulic Oil	See Traction Unit Operator's Manual
Hydraulic Reservoir Capacity	11 U.S. Gallons (41.6 L)

General Information

Traction Unit Operator's Manual

The Traction Unit Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Reelmaster machine. Refer to that publication for additional information when servicing the machine.

48 VDC Battery Disconnect

**CAUTION**

Before installing, removing or servicing components in the 48 VDC system (e.g. cutting unit motors, motor/generator), separate the 48 VDC battery disconnect. This will prevent unexpected operation of 48 VDC system components.

The 48 VDC battery disconnect is attached to the right frame rail under the operator seat (Fig. 1). Unplug the disconnect to make sure that 48 VDC components do not operate unexpectedly. Apply dielectric grease to the contact surfaces of the battery disconnect and plug the battery disconnect back in after service to the 48 VDC system is completed.

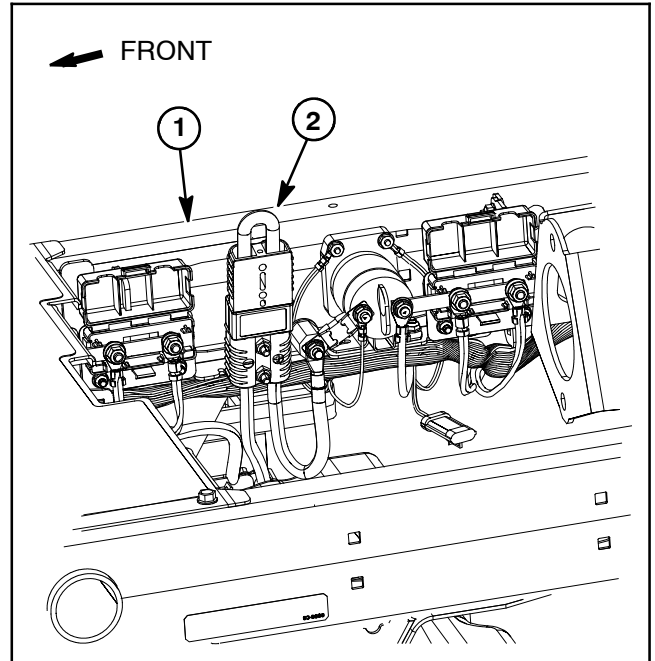


Figure 1

- 1. RH frame rail
- 2. 48V battery disconnect

Hydraulic System

Check Hydraulic Fluid

The hydraulic system on Reelmaster 5010- H machines is designed to operate on high quality hydraulic fluid. The hydraulic system reservoir holds approximately 11 gallons (41.6 liters) of hydraulic fluid. **Check level of hydraulic fluid daily.** See Traction Unit Operator's Manual for fluid level checking procedure and hydraulic oil recommendations.

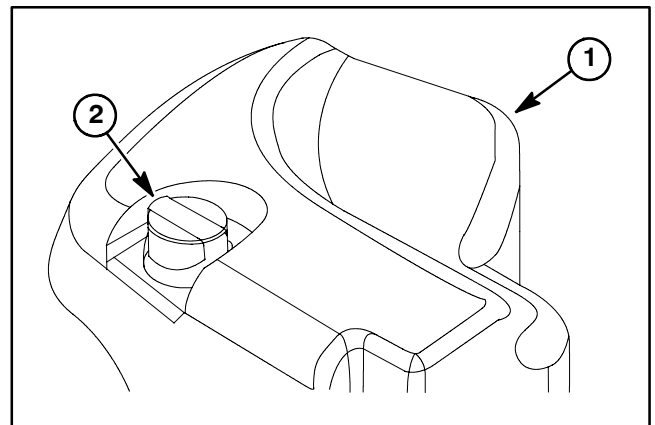


Figure 2

- 1. Hydraulic reservoir
- 2. Cap with dipstick

Towing Traction Unit

IMPORTANT: If towing limits are exceeded, severe damage to the piston (traction) pump may occur.

If it becomes necessary to tow or push the machine, tow or push at a speed below 3 mph (4.8 kph), and for a very short distance. If the machine needs to be moved a considerable distance, machine should be transported on a trailer. The piston (traction) pump is equipped with a bypass valve that needs to be loosened for towing or pushing (Fig. 3). See Traction Unit Operator's Manual for Towing Procedures.

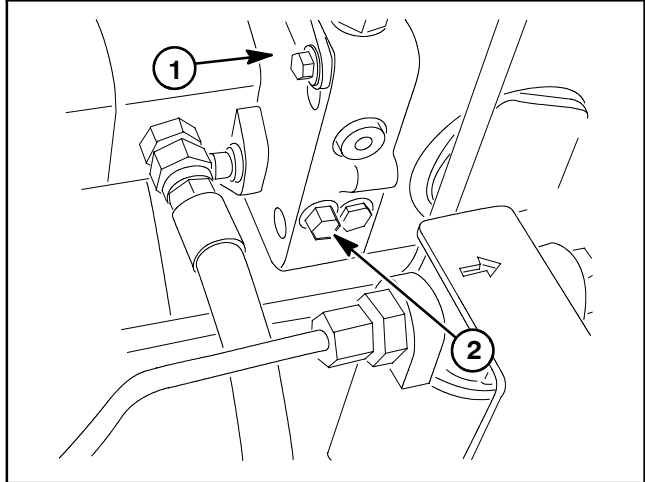


Figure 3

1. Piston (traction) pump 2. Bypass valve

Hydraulic Hoses

Hydraulic hoses are subject to extreme conditions such as pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions or mishandling during operation and maintenance. These conditions can cause hose damage and deterioration. Some hoses are more susceptible to these conditions than others. Inspect all machine hydraulic hoses frequently for signs of deterioration or damage:

Hard, cracked, cut, abraded, charred, leaking or otherwise damaged hose.

Kinked, crushed, flattened or twisted hose.

Blistered, soft, degraded or loose hose cover.

Cracked, damaged or badly corroded hose fittings.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint (layline) on the hose. Use two wrenches when tightening a hose; hold the hose straight with one wrench and tighten the hose swivel nut onto the fitting with the second wrench (see Hydraulic Hose and Tube Installation in this section). If the hose has an elbow at one end, tighten the swivel nut on that end before tightening the nut on the straight end of the hose.

For additional hydraulic hose information, refer to Toro Service Training Book, Hydraulic Hose Servicing (Part Number 94813SL).



WARNING

Before disconnecting or performing any work on hydraulic system, relieve all pressure in system (see Relieving Hydraulic System Pressure in this section).

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

Hydraulic Hose and Tube Installation (O-Ring Face Seal Fitting)

1. Make sure threads and sealing surfaces of the hose/tube and the fitting are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the face seal O-ring be replaced any time the connection is opened. Make sure the O-ring is installed and properly seated in the fitting groove. Lightly lubricate the O-ring with clean hydraulic oil.

3. Place the hose/tube against the fitting body so that the flat face of the hose/tube sleeve fully contacts the O-ring in the fitting.

4. Thread the swivel nut onto the fitting by hand. While holding the hose/tube with a wrench, use a torque wrench to tighten the swivel nut to the recommended installation torque shown in Figure 6. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 - Product Records and Maintenance).

5. If a torque wrench is not available or if space at the swivel nut prevents use of a torque wrench, an alternate method of assembly is the Flats From Wrench Resistance (F.F.W.R.) method (Fig. 2).

A. Using a wrench, tighten the swivel nut onto the fitting until light wrench resistance is reached (approximately 30 in-lb).

B. Mark the swivel nut and fitting body. Hold the hose/tube with a wrench to prevent it from turning.

C. Use a second wrench to tighten the nut to the correct Flats From Wrench Resistance (F.F.W.R.). The markings on the nut and fitting body will verify that the connection has been properly tightened.

Size	F.F.W.R.
4 (1/4 in. nominal hose or tubing)	1/2 to 3/4
6 (3/8 in.)	1/2 to 3/4
8 (1/2 in.)	1/2 to 3/4
10 (5/8 in.)	1/2 to 3/4
12 (3/4 in.)	1/3 to 1/2
16 (1 in.)	1/3 to 1/2

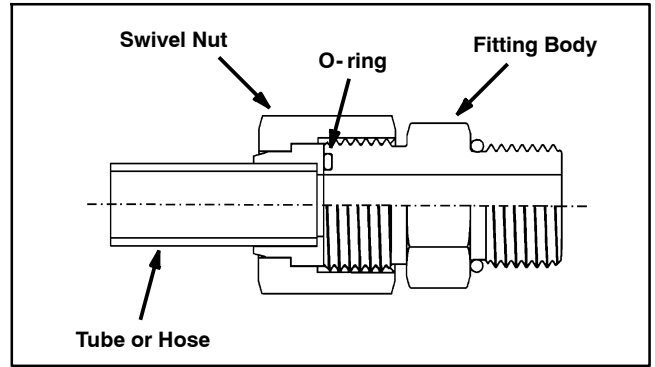


Figure 4

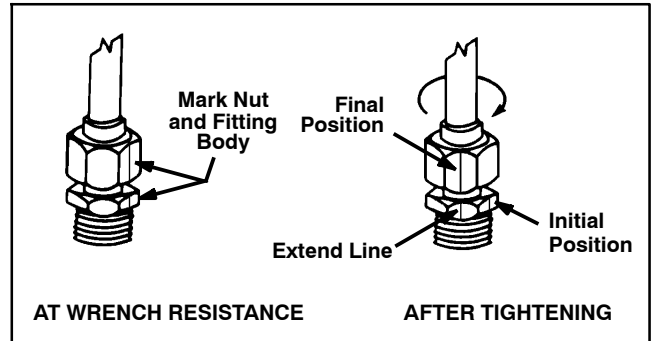


Figure 5

Fitting Dash Size	Hose/Tube Side Thread Size	Installation Torque
4	9/16 - 18	18 to 22 ft-lb (25 to 29 N-m)
6	11/16 - 16	27 to 33 ft-lb (37 to 44 N-m)
8	13/16 - 16	37 to 47 ft-lb (51 to 63 N-m)
10	1 - 14	60 to 74 ft-lb (82 to 100 N-m)
12	1 3/16 - 12	85 to 105 ft-lb (116 to 142 N-m)
16	1 7/16 - 12	110 to 136 ft-lb (150 to 184 N-m)
20	1 11/16 - 12	140 to 172 ft-lb (190 to 233 N-m)

Figure 6

Hydraulic Fitting Installation (SAE Straight Thread O-Ring Fitting into Component Port)

Non-Adjustable Fitting (Fig. 7)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.
2. As a preventative measure against leakage, it is recommended that the O-ring be replaced any time the connection is opened.
3. Lightly lubricate the O-ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.

4. Install the fitting into the port. Then, use a torque wrench and socket to tighten the fitting to the recommended installation torque shown in Figure 8.

NOTE: Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be less than the recommended installation torque. See Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 - Product Records and Maintenance to determine necessary conversion information.

5. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method.

A. Install the fitting into the port and tighten it down full length until finger tight.

B. If port material is steel, tighten the fitting to the listed F.F.F.T. If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

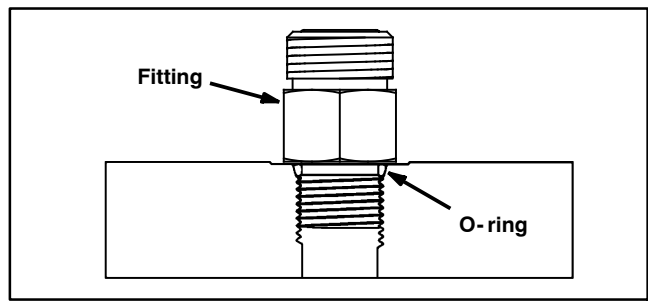


Figure 7

Fitting Dash Size	Fitting Port Side Thread Size	Installation Torque Into Steel Port	Installation Torque Into Aluminum Port
4	7/16 - 20	15 to 19 ft-lb (21 to 25 N-m)	9 to 11 ft-lb (13 to 15 N-m)
5	1/2 - 20	18 to 22 ft-lb (25 to 29 N-m)	11 to 15 ft-lb (15 to 20 N-m)
6	9/16 - 18	34 to 42 ft-lb (47 to 56 N-m)	20 to 26 ft-lb (28 to 35 N-m)
8	3/4 - 16	58 to 72 ft-lb (79 to 97 N-m)	35 to 43 ft-lb (48 to 58 N-m)
10	7/8 - 14	99 to 121 ft-lb (135 to 164 N-m)	60 to 74 ft-lb (82 to 100 N-m)
12	1 1/16 - 12	134 to 164 ft-lb (182 to 222 N-m)	81 to 99 ft-lb (110 to 134 N-m)
14	1 3/16 - 12	160 to 196 ft-lb (217 to 265 N-m)	96 to 118 ft-lb (131 to 160 N-m)
16	1 5/16 - 12	202 to 248 ft-lb (274 to 336 N-m)	121 to 149 ft-lb (165 to 202 N-m)
20	1 5/8 - 12	247 to 303 ft-lb (335 to 410 N-m)	149 to 183 ft-lb (202 to 248 N-m)

Figure 8

Adjustable Fitting (Fig. 9)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.
2. As a preventative measure against leakage, it is recommended that the O-ring be replaced any time the connection is opened.
3. Lightly lubricate the O-ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.
4. Turn back the lock nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1 in Figure 10).

IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2 in Figure 10). Make sure that the fitting does not bottom in the port during installation.
6. To put the fitting in the desired position, unscrew it by the required amount to align fitting with incoming hose or tube, but no more than one full turn (Step 3 in Figure 10).
7. Hold the fitting in the desired position with a wrench and use a torque wrench to tighten the lock nut to the recommended installation torque shown in Figure 8. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 - Product Records and Maintenance).
8. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method. Hold the fitting in the desired position with a wrench and, if port material is steel, tighten the lock nut with a second wrench to the listed F.F.F.T. (Step 4 in Figure 10). If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

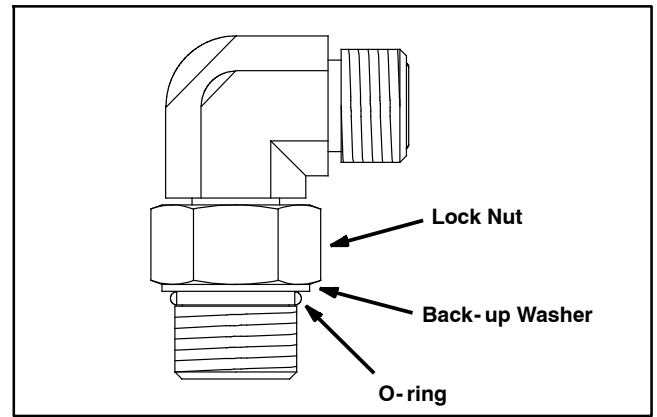


Figure 9

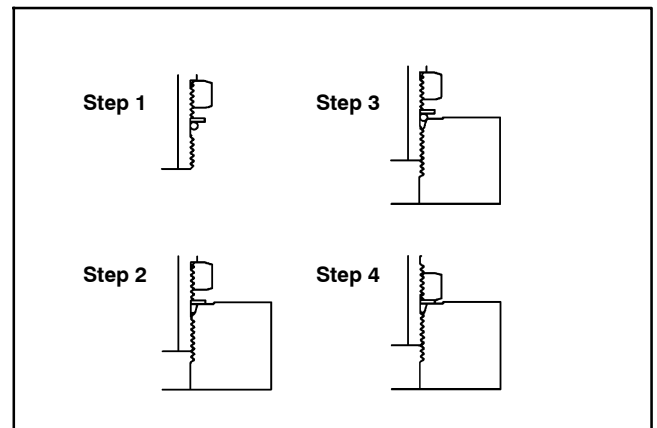


Figure 10

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the hydraulic system, all pressure in the hydraulic system must be relieved. Park machine on a level surface, lower cutting units fully, stop engine and engage parking brake.

To relieve hydraulic pressure in lift circuit, start engine and fully lower the cutting units. Turn key switch to OFF and remove key from the ignition switch.

To relieve hydraulic pressure in traction circuit, stop engine and move traction pedal to both forward and reverse directions.

To relieve hydraulic pressure in steering circuit, stop engine and rotate steering wheel in both directions.

Traction Circuit Component Failure

The traction circuit on Reelmaster 5010- H series machines is a closed loop system that includes the piston (traction) pump and two (2) front wheel motors (four (4) wheel motors on machines equipped with optional CrossTrax™ AWD kit). If a component in the traction circuit should fail, debris and contamination from the failed component will circulate throughout the traction circuit. This contamination can damage other components in the circuit so it must be removed to prevent additional component failure.

The recommended method of removing traction circuit contamination would be to temporarily install the Toro high flow hydraulic filter (see Special Tools in this chapter) into the circuit. This filter should be used when connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. traction (piston) pump or wheel motor). The filter will ensure that contaminants are removed from the closed loop and thus, do not cause additional component damage.

Once the Toro high flow hydraulic filter kit has been placed in the circuit, raise and support the machine with

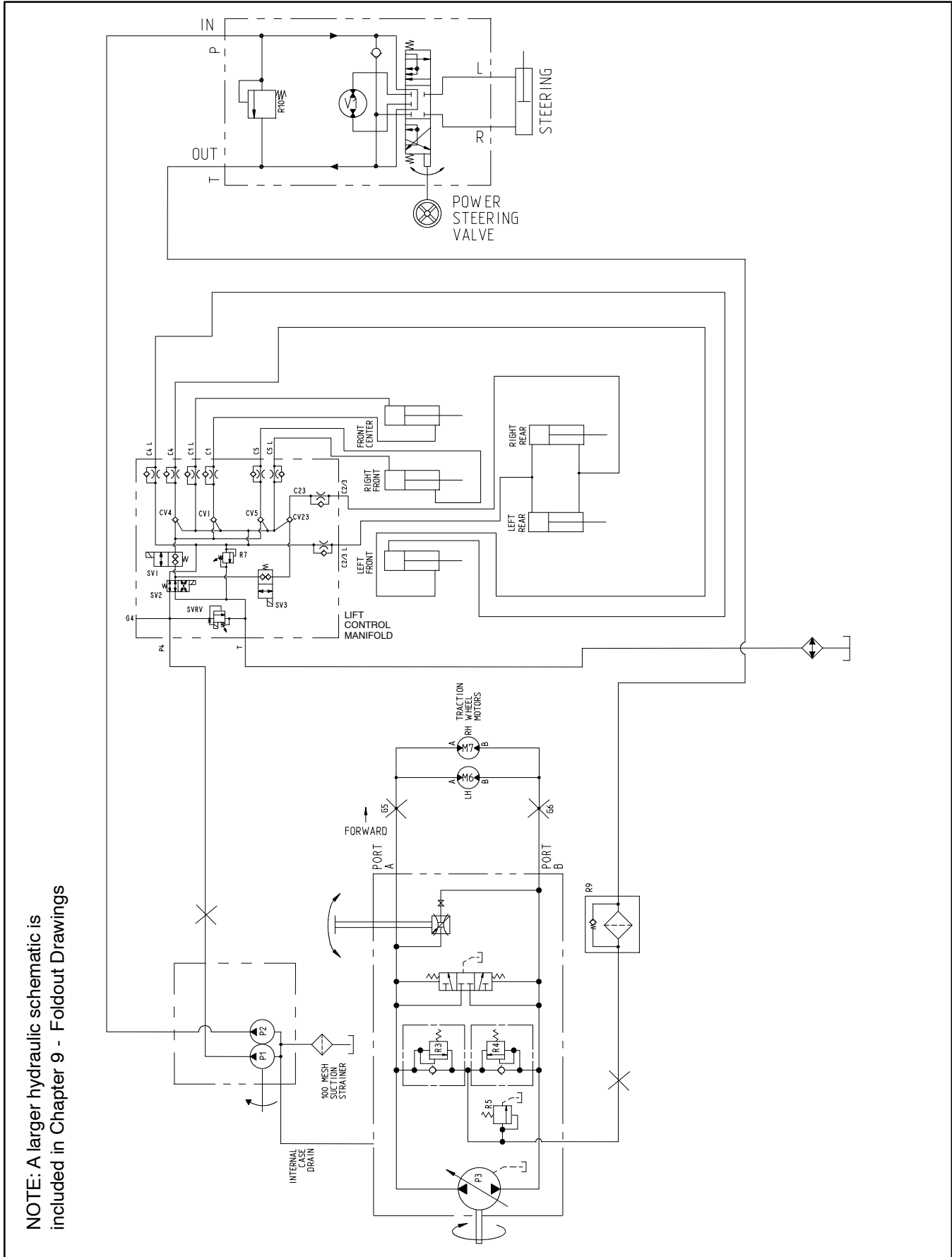
all wheels off the ground. Then, operate the traction circuit to allow oil flow throughout the circuit. The filter will remove contamination from the traction circuit during operation. Because the Toro high flow filter is bi-directional, the traction circuit can be operated in both the forward and reverse direction. The filter should be removed from the machine after contamination has been removed from the traction circuit. See Filtering Closed- Loop Traction Circuit in the Service and Repairs section of this chapter for additional information on using the Toro high flow hydraulic filter.

The alternative to using the Toro high flow hydraulic filter kit after a traction circuit component failure would be to disassemble, drain and thoroughly clean all components, hydraulic tubes and hydraulic hoses in the traction circuit. If any debris remains in the traction circuit and the machine is operated, the debris can cause additional circuit component failure.

NOTE: The piston (traction) pump case drain could allow traction circuit contamination to contaminate other hydraulic circuits on the machine.

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Hydraulic Schematic



NOTE: A larger hydraulic schematic is included in Chapter 9 - Foldout Drawings

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Hydraulic Flow Diagrams

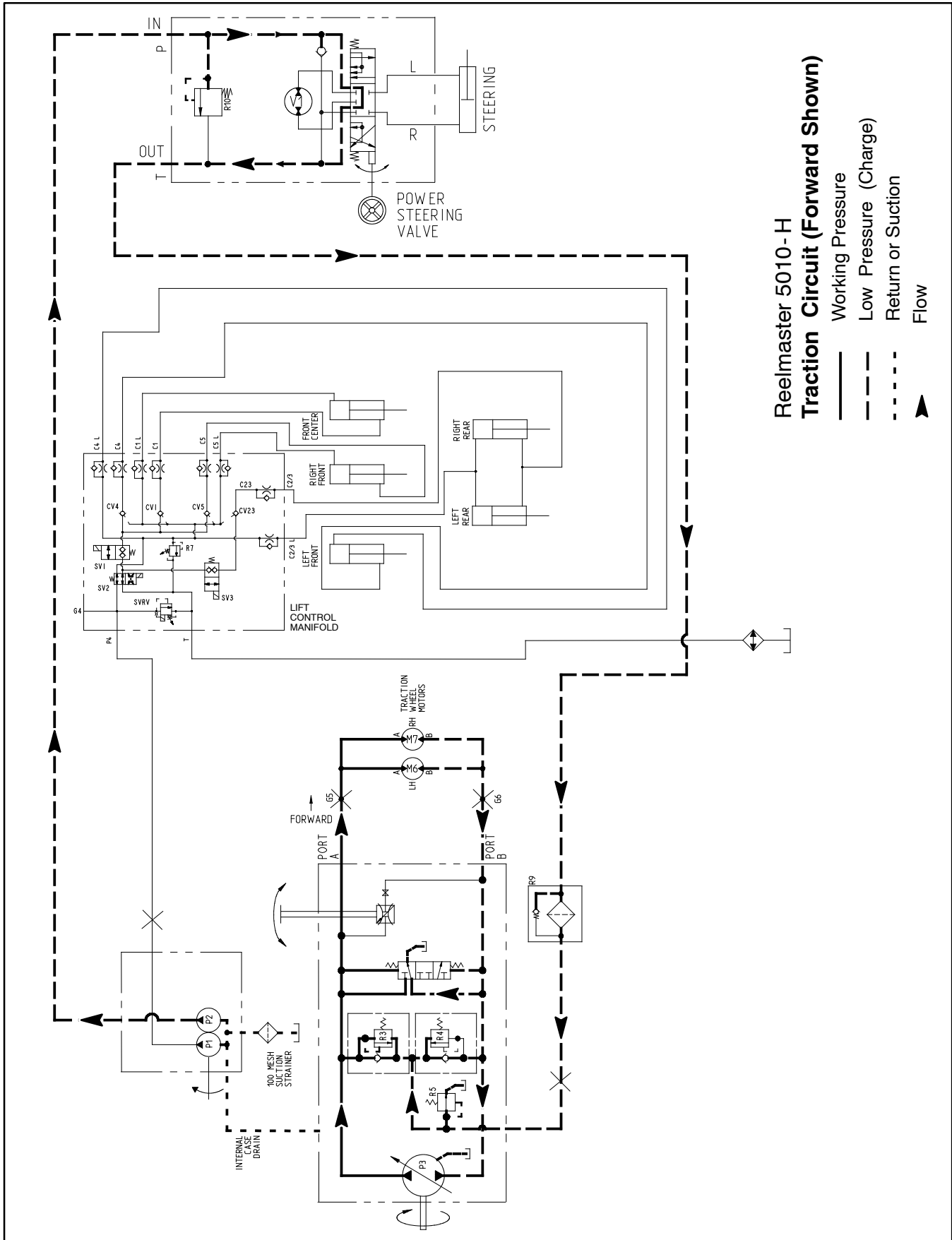


Figure 11

Traction Circuit

The hydraulic traction circuit consists of a variable displacement piston pump (P3) connected in a closed loop, parallel circuit to two (2) orbital roller vane wheel motors. The piston (traction) pump input shaft is rotated by a drive shaft connected to the motor/generator shaft that is driven by the engine flywheel.

Traction circuit pressure (forward and reverse) can be measured at test ports located in the hydraulic tubes that connect the front wheel motors.

NOTE: In high load traction situations, the 48 VDC motor/generator may automatically assist the engine to maintain piston (traction) pump input speed.

Forward Direction (Fig. 11)

Pushing the top of the traction pedal angles the piston (traction) pump swash plate to create a flow of oil. This oil flow is directed to the wheel motors via hydraulic hoses and tubes to drive the wheels in the forward direction. Forward traction pressure is limited to 3625 PSI (250 bar) by the forward traction relief valve (R3) located in the piston (traction) pump.

Oil flowing from the wheel motors returns to the variable displacement pump and is continuously pumped through the traction circuit as long as the traction pedal is pushed.

The angle of the swash plate determines pump flow and ultimately traction speed. When the traction pedal is depressed a small amount, a small swash plate rotation results in low pump output and lower traction speed. When the traction pedal is depressed fully, the pump swash plate rotates fully to provide maximum pump output and traction speed.

Gear pump section (P2) supplies oil flow for the steering circuit and also provides a constant supply of charge oil to the closed loop traction circuit. This charge oil provides lubrication for traction circuit components and also replenishes traction circuit oil that is lost due to internal leakage in the traction circuit.

The hydraulic reservoir provides fluid for the gear pump (P2) through the suction hose. Charge pump flow is directed to the low pressure side of the closed loop traction circuit. Charge pressure is limited by the charge relief valve (R5) located in the piston (traction) pump. The charge relief pressure is 200 PSI (14 bar).

The piston pump (P3) includes a flushing valve that bleeds off a small amount of hydraulic fluid for cooling of the closed loop traction circuit. The charge system replenishes oil that is bled from the traction circuit by the flushing valve.

Reverse Direction

The traction circuit operates essentially the same in reverse as it does in the forward direction. However, the flow through the circuit is reversed. Pushing the bottom of the traction pedal rotates the piston (traction) pump swash plate to create a flow of oil. This oil is directed to the wheel motors to drive the wheels in the reverse direction. Reverse traction pressure is limited to 3625 PSI (250 bar) by the reverse traction relief valve (R4) located in the piston (traction) pump.

Oil flowing from the wheel motors returns to the piston (traction) pump and is continuously pumped through the closed loop traction circuit as long as the traction pedal is pushed.

The charge circuit and flushing valve function the same in reverse as they do in the forward direction.

CrossTrax™ AWD (Optional)

On machines equipped with the optional CrossTrax™ AWD kit, four (4) wheel motors are used (Fig. 12). Piston (traction) pump flow is directed to the front tires and the opposite rear tires to maximize traction. To reduce tire scuffing when turning, traction system pressure is equalized in the AWD manifold with an orifice and a bi-directional relief valve. Check valves in the AWD manifold allow the rear wheel motors to over run during tight turns.

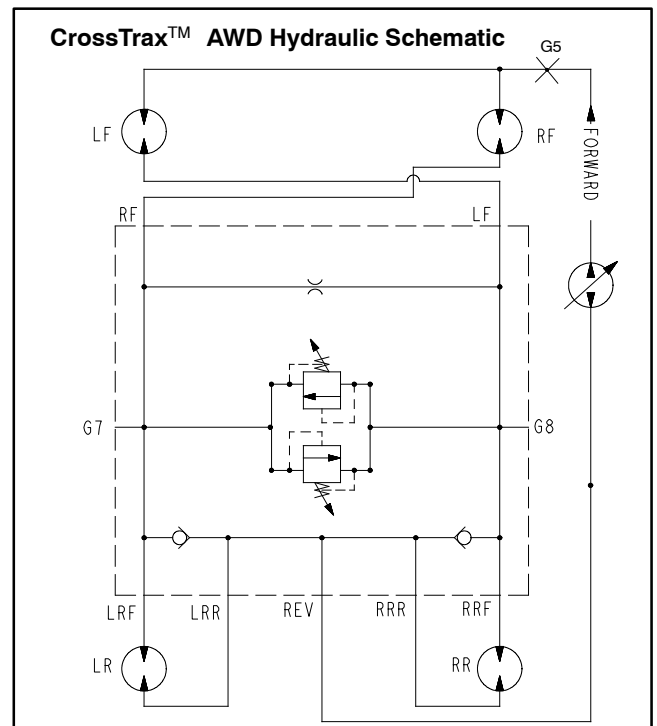


Figure 12

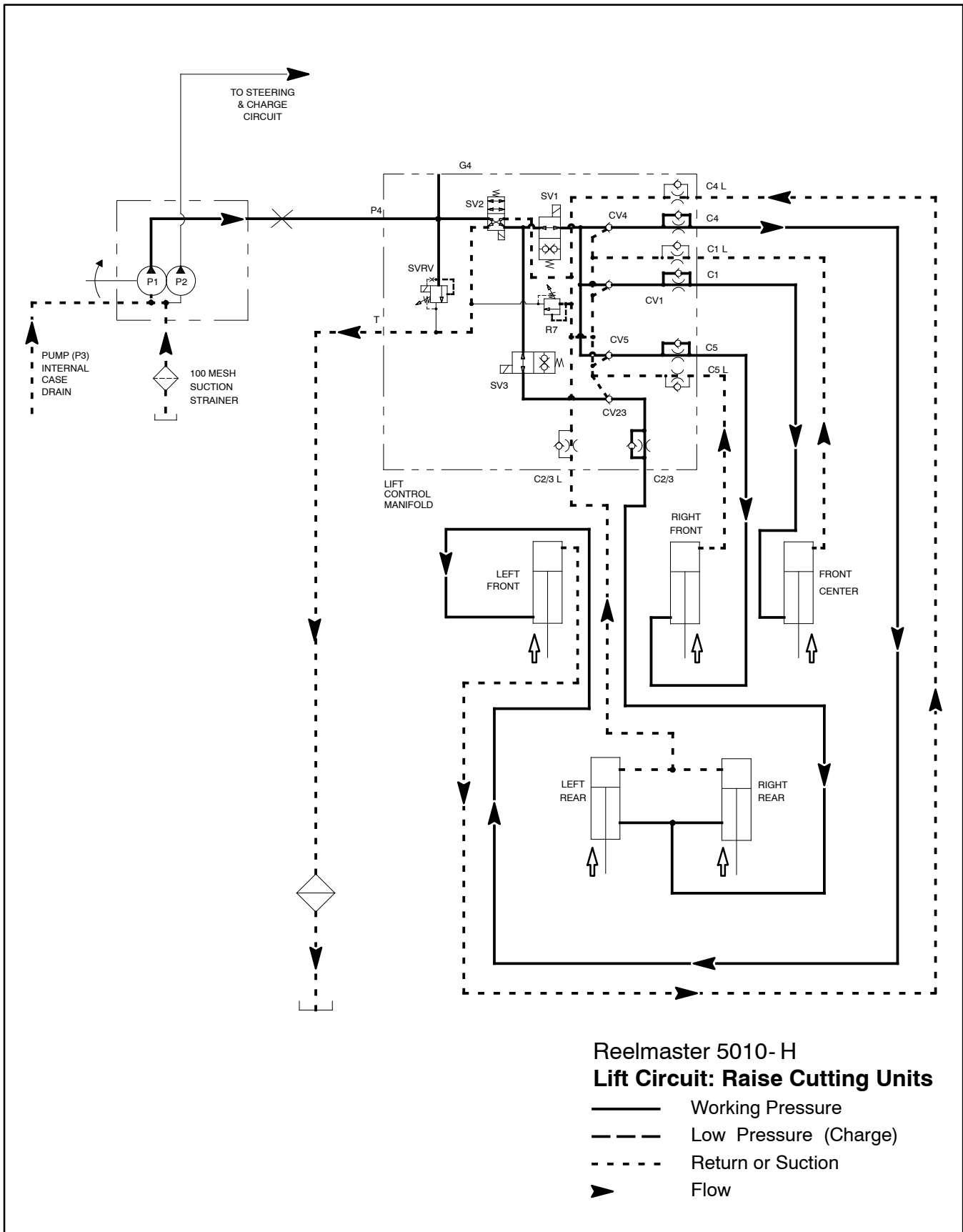


Figure 13

Lift Circuit: Raise Cutting Units

A two section gear pump is coupled to the piston (traction) pump. Gear pump section (P1) supplies hydraulic flow to the lift control manifold and ultimately for the lift cylinders. The hydraulic reservoir provides fluid for the gear pump through the suction hose. Lift circuit pressure is limited to 2000 PSI (138 bar) by a solenoid relief valve (SVRV) located in the lift control manifold.

The lift control manifold includes four (4) electrically operated solenoid valves. Valve (SVRV) is used to direct gear pump flow to the lift cylinders when energized or bypass pump flow back to the reservoir when de-energized. Valve (SV2) is used to direct oil flow to retract the lift cylinders when energized or extend them when de-energized. Valve (SV1) allows hydraulic flow to the front lift cylinders when energized. Valve (SV3) allows hydraulic flow to the rear lift cylinders when energized.

Lift circuit pressure can be monitored at lift control manifold port G4.

The TEC controller uses inputs from various machine switches to determine when lift manifold solenoid valves (SV1, SV2, SV3 and SVRV) are to be energized. The TEC also provides a partial raise position of the front outside cutting units.

During conditions of not raising or lowering the cutting units (joystick in the neutral (center) position), all four (4) lift manifold solenoid valves (SV1, SV2, SV3 and SVRV) are de-energized. Hydraulic flow from gear pump section (P1) by-passes the lift cylinders to the oil cooler and then to the hydraulic reservoir.

Raise Cutting Units (Fig. 13)

When the joystick is moved to the raise position, solenoid valve (SVRV) energizes along with solenoid valves (SV1), (SV2) and (SV3). The energized solenoid valves direct gear pump section P4 oil flow to the rod end of the lift cylinders. Hydraulic pressure against the rod side of the cylinders causes the shafts to retract, and raises the cutting units. Fixed orifices in the lift control manifold (C1L, C4L, C5L and C23L) control the lifting speed by providing a restriction for the return flow from the lift cylinders.

When the joystick is returned to the neutral (center) position, the lift manifold solenoid valves are de-energized and the lift cylinders (and cutting units) are held in the raised position. Piloted check valves in the lift control manifold (CV1, CV4, CV5 and CV23) prevent the lift cylinders (and cutting units) from dropping after they have been raised.

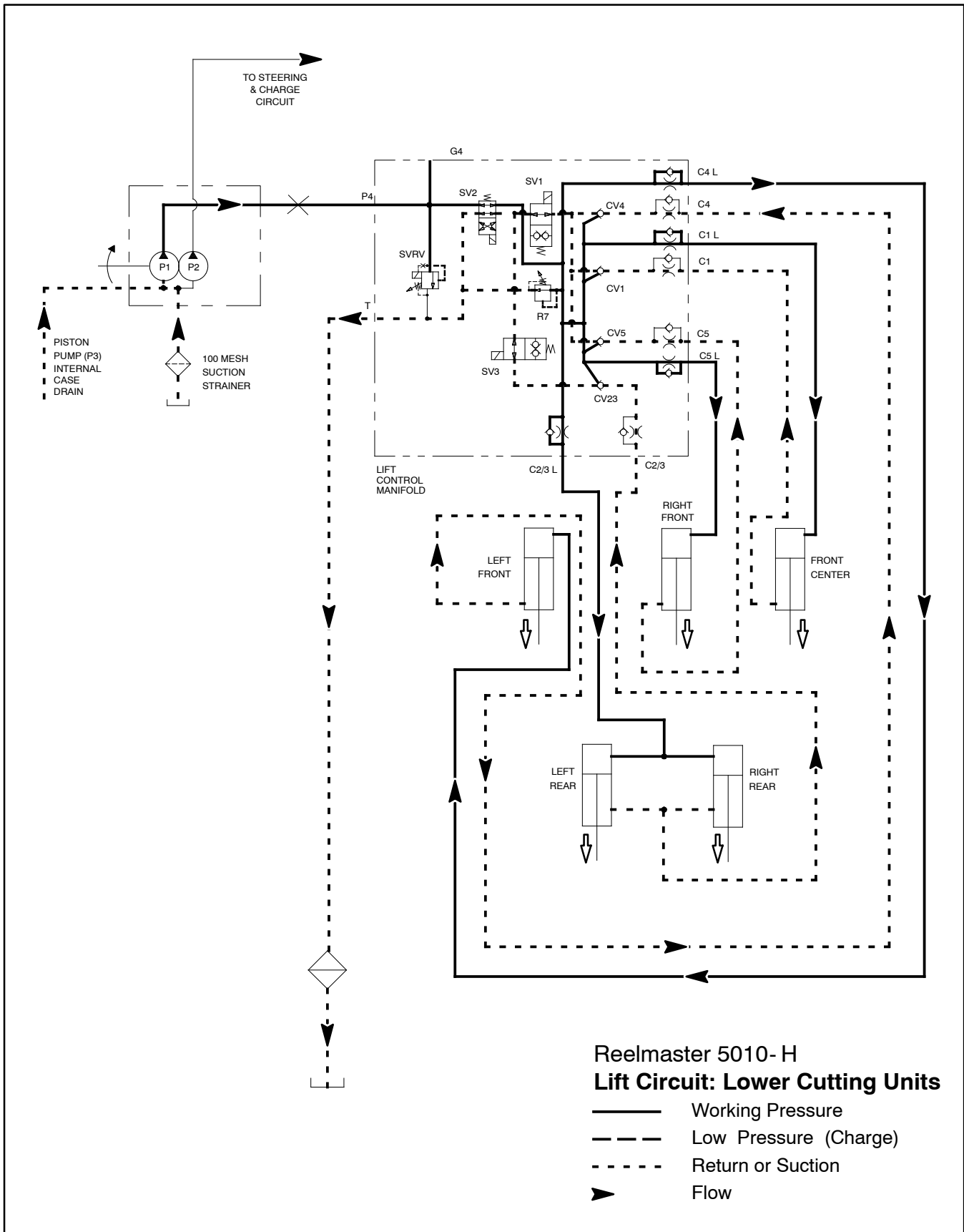


Figure 14

Lift Circuit: Lower Cutting Units

A two section gear pump is coupled to the piston (traction) pump. Gear pump section (P1) supplies hydraulic flow to the lift control manifold and ultimately for the lift cylinders. The hydraulic reservoir provides fluid for the gear pump through the suction hose. Lift circuit pressure is limited to 2000 PSI (138 bar) by a solenoid relief valve (SVRV) located in the lift control manifold.

The lift control manifold includes four (4) electrically operated solenoid valves. Valve (SVRV) is used to direct gear pump flow to the lift cylinders when energized or bypass pump flow back to the reservoir when de-energized. Valve (SV2) is used to direct oil flow to retract the lift cylinders when energized or extend them when de-energized. Valve (SV1) allows hydraulic flow to the front lift cylinders when energized. Valve (SV3) allows hydraulic flow to the rear lift cylinders when energized.

Lift circuit pressure can be monitored at lift control manifold port G4.

The TEC controller uses inputs from various machine switches to determine when lift manifold solenoid valves (SV1, SV2, SV3 and SVRV) are to be energized. The TEC also provides a partial raise position of the front outside cutting units.

During conditions of not raising or lowering the cutting units (joystick in the neutral (center) position), all four (4) lift manifold solenoid valves (SV1, SV2, SV3 and SVRV) are de-energized. Hydraulic flow from gear pump section (P1) by-passes the lift cylinders to the oil cooler and then to the hydraulic reservoir.

Lower Cutting Units (Fig. 14)

When the joystick is moved to the lower position, solenoid valve (SVRV) energizes along with solenoid valves (SV1) and (SV3). Solenoid valve (SV2) is in its normally de-energized position, and directs oil flow to the piston end of the lift cylinders. Hydraulic pressure against the piston side of the cylinder causes the shafts to extend, and lower the cutting units. The piloted check valves in the lift control manifold (CV1, CV4, CV5 and CV23) are shifted by hydraulic pressure to allow return flow from the extending lift cylinders. Fixed orifices in the lift control manifold (C1, C4, C5 and C23) control the lowering speed by providing a restriction for the return flow from the lift cylinders.

Because cutting unit weight assists in extending the lift cylinders when lowering the cutting units, less hydraulic pressure is necessary during the cutting unit lowering operation. Lift circuit lower relief valve (R7) allows lift circuit pressure to be limited to 500 PSI (35 bar) while lowering the cutting units.

NOTE: Adjustment of lift circuit lower relief valve (R7) is not recommended.

When the joystick is returned to the neutral (center) position, the solenoid valves are de-energized and the lift cylinders (and cutting units) are held in the lowered position.

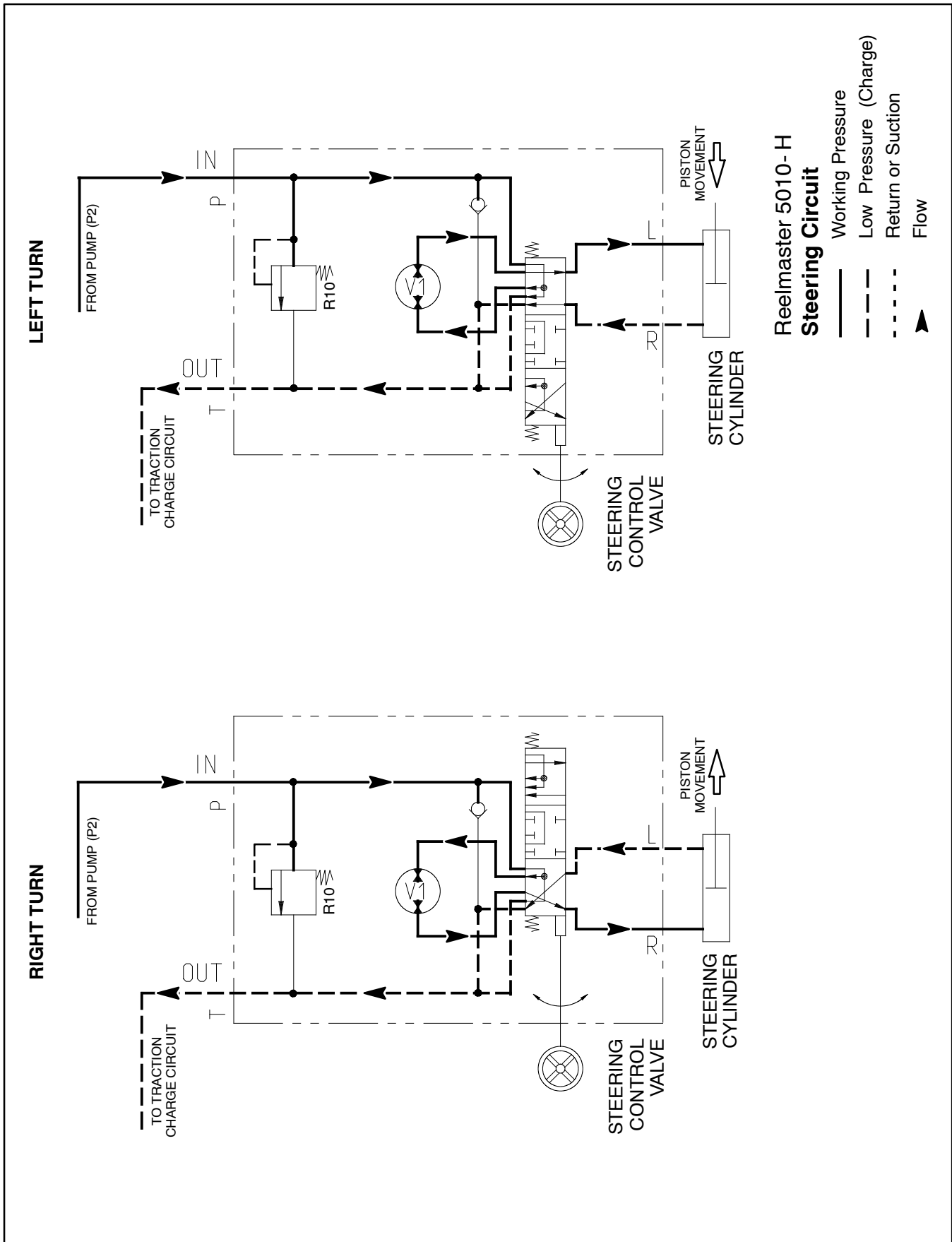


Figure 15

Steering Circuit

A two section gear pump is coupled to the piston (traction) pump. Gear pump section P2 supplies hydraulic flow to the steering control valve and for the traction charge circuit. The hydraulic reservoir provides fluid for the gear pump through the suction hose. Steering circuit pressure is limited to 1000 PSI (70 bar) by a relief valve (R10) located in the steering control.

With the steering wheel in the neutral position and the engine running, flow enters the steering control valve at the P port and goes through the steering control spool valve, by-passing the rotary meter (V1) and steering cylinder. Flow leaves the control valve through the T port to the hydraulic oil filter and traction charge circuit.

Left Turn (Fig. 15)

When a left turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow is directed through the bottom of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. First, most of the flow through the valve is by-passed out the T port back to the hydraulic oil filter and traction charge circuit. Second, the remainder of the flow is drawn through the rotary meter (V1) and out the L port. Pressure contracts the steering cylinder piston for a left turn. The rotary meter ensures that the oil flow to the steering cylinder is proportional to the amount of turning on the steering wheel. Fluid leaving the steering cylinder flows back through the steering control spool valve and then out of the steering control valve through the T port and to the oil filter and traction charge circuit.

The steering control valve returns to the neutral position when turning is completed.

Right Turn (Fig. 15)

When a right turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow is directed through the top of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. As in a left turn, most of the flow through the valve is by-passed out the T port back to the hydraulic oil filter and traction charge circuit. Also like a left turn, the remainder of the flow is drawn through rotary meter (V1) but goes out port R. Pressure extends the steering cylinder piston for a right turn. The rotary meter ensures that the oil flow to the steering cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the steering cylinder flows back through the steering control spool valve then through the T port and to the oil filter and traction charge circuit.

The steering control valve returns to the neutral position when turning is completed.

Special Tools

Order these special tools from your Toro Distributor.

Hydraulic Pressure Test Kit

Toro Part Number: **TOR47009**

Use to take various pressure readings for diagnostic tests. Quick disconnect fittings provided attach directly to mating fittings on machine test ports without tools. A high pressure hose is provided for remote readings. Contains one each: 1000 PSI (70 bar), 5000 PSI (350 bar) and 10000 PSI (700 bar) gauges. Use gauges as recommended in the Testing section of this chapter.



Figure 16

15 GPM Hydraulic Tester Kit (Pressure and Flow)

Toro Part Number: **TOR214678**

Use to test hydraulic circuits and components for flow and pressure capacities as recommended in the Testing section of this chapter. This tester includes the following:

1. **INLET HOSE:** Hose connected from the system circuit to the inlet side of the hydraulic tester.
2. **LOAD VALVE:** A simulated working load is created in the circuit by turning the valve to restrict flow.
3. **PRESSURE GAUGE:** Glycerine filled 0 to 5000 PSI gauge to provide operating circuit pressure.
4. **FLOW METER:** This meter measures actual oil flow in the operating circuit with a gauge rated from 1 to 15 GPM (5 to 55 LPM).
5. **OUTLET HOSE:** A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.
6. **FITTINGS:** An assortment of hydraulic fittings are included with this kit.



Figure 17

40 GPM Hydraulic Tester (Pressure and Flow)

Toro Part Number: **AT40002**

Use to test hydraulic circuits and components for flow and pressure capacities as recommended in the Testing section of this chapter. This tester includes the following:

1. **LOAD VALVE:** A simulated working load is created in the circuit by turning the valve to restrict flow.
2. **PRESSURE GAUGE:** Glycerine filled 0 to 5000 PSI gauge to provide operating circuit pressure.
3. **FLOW METER:** This meter measures actual oil flow in the operating circuit with a gauge rated from 4 to 40 GPM (20 to 150 LPM).

NOTE: This tester does not include hydraulic hoses (see Hydraulic Hose Kit TOR6007 below).



Figure 18

Hydraulic Hose Kit

Toro Part Number: **TOR6007**

This kit includes hydraulic fittings and hoses needed to connect 40 GPM hydraulic tester (AT40002) or high flow hydraulic filter kit (TOR6011) to machine hydraulic traction system components.



Figure 19

High Flow Hydraulic Filter Kit

Toro Part Number: **TOR6011**

The high flow hydraulic filter kit is designed with large flow (40 GPM/150 LPM) and high pressure (5000 PSI/345 bar) capabilities. This kit provides for bi-directional filtration which prevents filtered debris from being allowed back into the circuit regardless of flow direction.

If a component failure occurs in the closed loop traction circuit, contamination from the failed part will remain in the circuit until removed. When connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. piston pump or wheel motor), the high flow hydraulic filter can be installed in the traction circuit. The filter will ensure that contaminants are removed from the closed loop and thus, do not cause additional component damage.

NOTE: This kit does not include hydraulic hoses (see Hydraulic Hose Kit TOR6007 above).

NOTE: Replacement filter element is Toro part number TOR6012. Filter element cannister tightening torque is **25 ft-lb (34 N-m)**.



Figure 20

O-Ring Kit

Toro Part Number: **117-2727**

The O-ring kit includes O-rings in a variety of sizes for face seal and port seal hydraulic connections. It is recommended that O-rings be replaced whenever a hydraulic connection is loosened.



Figure 21

Hydraulic Test Fitting Kit

Toro Part Number: **TOR4079**

This kit includes a variety of O-ring face seal fittings to enable the connection of test gauges into the system.

The kit includes: tee's, unions, reducers, plugs, caps and male test fittings.








TORO TEST FITTING KIT (TOR4079)			
FITTING	TOOL NUMBER	FITTING	TOOL NUMBER
	Swivel Nut Run Tee (2 ea.) Size Toro No. No. 4 TOR4079-3 No. 6 TOR4079-12 No. 8 TOR4079-4 No. 10 TOR4079-5		Union (1 ea.) Size Toro No. No. 6 to No. 8 TOR4079-6 No. 10 to No. 8 TOR4079-2 No. 8 to No. 8 TOR4079-9
	Plug (2 ea.) Size Toro No. No. 4 TOR4079-13 No. 6 TOR4079-14 No. 8 TOR4079-15 No. 10 TOR4079-16		Reducer (1 ea.) Size Toro No. No. 10 to No. 8 TOR4079-7 No. 12 to No. 8 TOR4079-6
	Cap (2 ea.) Size Toro No. No. 4 TOR4079-17 No. 6 TOR4079-18 No. 8 TOR4079-19 No. 10 TOR4079-20		Test Cap Fitting (2 ea.) Size Toro No. No. 4 TOR4079-10 No. 6 TOR4079-11 No. 8 TOR4079-21 No. 10 TOR4079-1
			Test Fitting (2 ea.) Size Toro No. 7/16-20 ORB TOR4079-22 1/8" Pipe Thd. TOR4079-23

Figure 22

Measuring Container

Toro Part Number: **TOR4077**

Use this graduated container for doing hydraulic motor efficiency testing (motors with case drain lines only). Measure efficiency of a hydraulic motor by restricting the outlet flow from the motor and measuring leakage from the case drain line while the motor is pressurized by the hydraulic system.

The table in Figure 24 provides gallons per minute (GPM) conversion for measured milliliter or ounce motor case drain leakage.



Figure 23

GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

Figure 24

Wheel Hub Puller

The wheel hub puller allows safe removal of the wheel hub from the wheel motor shaft.

Toro Part Number: **TOR6004**



Figure 25

Troubleshooting

The cause of an improperly functioning hydraulic system is best diagnosed with the use of proper testing equipment and a thorough understanding of the complete hydraulic system.

A hydraulic system with an excessive increase in heat or noise has a potential for failure. Should either of these conditions be noticed, immediately stop the machine, turn off the engine, locate the cause of the trouble and correct it before allowing the machine to be used again.

Continued use of an improperly functioning hydraulic system could lead to extensive hydraulic component damage.

The charts that follow contain information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction.

Refer to the Testing section of this chapter for precautions and specific hydraulic test procedures.

General Hydraulic System Problems

Problem	Possible Cause
Hydraulic oil leaks from machine	Fitting(s), hose(s) or tube(s) is (are) loose or damaged. O- ring(s) or seal(s) is (are) missing or damaged.
Foaming hydraulic fluid	Oil level in hydraulic reservoir is low. Hydraulic system has wrong kind of oil. Pump suction line has an air leak.
Hydraulic system operates hot	Traction system pressure is high due to excessive load or brake dragging or binding. Oil level in hydraulic reservoir is low. Hydraulic oil is contaminated or too light. Engine speed is too low. Engine fan is not operating properly. Oil cooler is damaged or plugged. Air flow through oil cooler is obstructed. Hydraulic oil filter is plugged. Charge pressure is low. Piston (traction) pump bypass valve is open or faulty. Piston (traction) pump check valve is not seating or is damaged. Wheel motor(s) and/or piston (traction) pump are worn or damaged (NOTE: If a traction circuit component has internal wear or damage, it is possible that other traction components are also damaged).

Hydraulic System

Traction Circuit Problems

Problem	Possible Cause
Neutral is difficult to find or unit operates in one direction only	<p>Traction control linkage is misadjusted, disconnected, binding or damaged.</p> <p>Piston (traction) pump check relief valve is not seating or is damaged (NOTE: Piston (traction) pump check relief valves for forward and reverse are identical and can be reversed for testing purposes).</p> <p>Piston (traction) pump is worn or damaged.</p>
Traction response is sluggish	<p>Charge pressure is low.</p> <p>Hydraulic oil is very cold.</p> <p>Parking brake is dragging or binding.</p> <p>Piston (traction) pump bypass valve is not seated.</p> <p>Flushing valve in piston (traction) pump is not seating or is damaged.</p> <p>Piston (traction) pump charge relief valve is not seating or is damaged.</p> <p>Piston (traction) pump check relief valve is not seating or is damaged (NOTE: Check relief valves for forward and reverse are identical and can be reversed for testing purposes).</p> <p>Piston (traction) pump is worn or damaged.</p>
No traction in either direction	<p>Parking brake is dragging or binding.</p> <p>Traction control linkage is misadjusted, disconnected, binding or damaged.</p> <p>Oil level in hydraulic reservoir is low (other hydraulic systems affected as well).</p> <p>Piston (traction) pump bypass valve is loosened.</p> <p>Flushing valve in piston (traction) pump is not seating or is damaged.</p> <p>Piston (traction) pump check valve is not seating or is damaged.</p> <p>Charge pressure is low.</p> <p>Wheel motor(s) and/or piston (traction) pump are worn or damaged (NOTE: If a traction circuit component has internal wear or damage, it is possible that other traction components are also damaged).</p>
Single wheel motor turns while unloaded, but slows down or stops when load is applied	<p>Wheel motor is worn or damaged.</p> <p>(NOTE: If a traction circuit component has internal wear or damage, it is possible that other traction components are also damaged)</p>

Traction Circuit Problems (Continued)

Problem	Possible Cause
Wheel motor will not turn	<p>Brakes are binding.</p> <p>Wheel motor is worn or damaged.</p> <p>(NOTE: If a traction circuit component has internal wear or damage, it is possible that other traction components are also damaged)</p>

Lift Circuit Problems

Problem	Possible Cause
Single cutting unit lifts slowly or not at all	<p>Affected cutting unit has excessive debris buildup.</p> <p>Lift arm or lift cylinder for the affected cutting unit is binding.</p> <p>Pilot piston in lift control manifold for the affected cutting unit is stuck or damaged.</p> <p>Lift cylinder for the affected cutting unit leaks internally.</p> <p>Flow control orifice in lift control manifold for the affected cutting unit is plugged or damaged.</p>
<p>Cutting units raise, but will not remain in the raised position</p> <p>(NOTE: Lift cylinders and control manifold check valves cannot provide an absolutely perfect seal. The cutting units will eventually lower if left in the raised position)</p>	<p>Lift cylinder leaks internally.</p> <p>Lift control manifold check valve(s) (CV1, CV4, CV5 and CV23) and solenoid valve (SV1 and SV3) leaks.</p> <p>Pilot piston in lift control manifold is stuck and is preventing check valve from seating.</p>
None of the cutting units will raise or lower	<p>Oil level in hydraulic reservoir is low (other hydraulic systems affected as well).</p> <p>Cutting units are in the backlap position (NOTE: Operator advisory should be displayed on InfoCenter Display).</p> <p>Solenoid valve SVRV on lift control manifold is faulty.</p> <p>An electrical problem exists that prevents SVRV solenoid coil on the lift control manifold from being energized (see Troubleshooting in Chapter 5 - Electrical System).</p> <p>Gear pump section for lift/lower function (P1) is worn or damaged.</p>

Lift Circuit Problems (Continued)

Problem	Possible Cause
None of the front cutting units will raise or lower but the rear cutting units will raise and lower	<p>Solenoid valve SV1 on lift control manifold is faulty.</p> <p>An electrical problem exists that prevents SV1 solenoid coil on the lift control manifold from being energized (see Troubleshooting in Chapter 5 - Electrical System).</p>
Neither of the rear cutting units will raise or lower but the front cutting units will raise and lower	<p>Solenoid valve SV3 on lift control manifold is faulty.</p> <p>An electrical problem exists that prevents SV3 solenoid coil on the lift control manifold from being energized (see Troubleshooting in Chapter 5 - Electrical System).</p> <p>Flow control orifice in lift control manifold for the rear cutting units (C23 or C23L) is plugged or damaged.</p> <p>Check valve in lift control manifold for the rear cutting units (CV23) is stuck or damaged.</p>
Single cutting unit lowers very slowly or not at all	<p>Lift arm or lift cylinder for the affected cutting unit is binding.</p> <p>Lift cylinder for the affected cutting unit is damaged.</p> <p>Flow control orifice in lift control manifold for the affected cutting unit is plugged or damaged.</p> <p>Check valve in lift control manifold (CV1, CV4, CV5 and CV23) is stuck or damaged.</p>

Steering Circuit Problems

Problem	Possible Cause
Steering inoperative or sluggish	<p>Steering components (e.g. tie rods, steering cylinder ends) are worn or binding.</p> <p>Steering cylinder is binding.</p> <p>Oil level in hydraulic reservoir is low (other hydraulic systems affected as well).</p> <p>Steering relief valve (R10) in steering control valve is stuck or damaged.</p> <p>Steering cylinder leaks internally.</p> <p>Steering control valve is worn or damaged.</p> <p>Internal gear pump drive coupler is damaged.</p> <p>Gear pump section (P2) is worn or damaged (NOTE: A worn or damaged gear pump section (P2) will also affect the traction (charge) circuit).</p>

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Testing


The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks (see the Special Tools section in this chapter).


Before Performing Hydraulic Tests

IMPORTANT: All obvious areas such as oil supply, oil filter, binding linkages, loose fasteners or improper adjustments must be checked before assuming that a hydraulic component is the source of a hydraulic system problem.

Precautions for Hydraulic Testing

	CAUTION
<p>Failure to use gauges with expected pressure (psi) rating as listed in test procedures could result in damage to the gauge and possible personal injury from leaking hot oil.</p>	

	CAUTION
<p>All testing should be performed by two (2) people. One person should be in the seat to operate the machine and the other should monitor test equipment and record test results.</p>	


	WARNING
<p>Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Do not use hands to search for leaks; use paper or cardboard. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.</p>	

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination can cause excessive wear or binding of hydraulic components.

2. Review all test steps before starting the test procedure.

3. Before testing, check all control linkages for improper adjustment, binding or broken parts.

4. All hydraulic tests should be made with the hydraulic oil at normal operating temperature. Operate the machine under load for at least ten (10) minutes before performing hydraulic tests.

	WARNING
<p>Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.</p>	

5. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or component removal.

6. When using hydraulic tester (pressure and flow), the inlet and the outlet hoses must be properly connected and not reversed to prevent damage to the hydraulic tester or components.

7. Install hydraulic fittings finger tight and far enough to make sure that they are not cross-threaded before tightening them with a wrench.

8. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.

9. After connecting test equipment, check oil level in the hydraulic reservoir to make sure that oil level is correct.

10. When using hydraulic tester (pressure and flow), open tester load valve completely before starting engine to minimize the possibility of damaging components.

11. The engine must be in good operating condition. Use a phototac when performing a hydraulic test. Engine speed can affect the accuracy of the tester readings. Check actual speed of the pump when performing hydraulic flow tests.

12. After hydraulic test procedures have been completed, check oil level in the hydraulic reservoir to make sure that oil level is correct.

Which Hydraulic Tests Are Necessary?

Before beginning any hydraulic test, identify if the problem is related to the traction circuit, lift circuit or steering circuit. Once the faulty system has been identified, perform tests that relate to that circuit.

1. If a traction circuit problem exists, consider performing one or more of the following tests: Traction Circuit Relief Valve (R3) and (R4) Pressure, Traction Circuit Charge Pressure, Gear Pump (P2) Flow, Front Wheel Motor Efficiency and/or Piston (Traction) Pump Flow Tests.
2. If a lift circuit problem exists, consider performing one or more of the following tests: Lift Relief Valve (SVRV) Pressure, Gear Pump (P1) Flow and/or Lift Cylinder Internal Leakage Tests.
3. If a steering circuit problem exists, consider performing one or more of the following tests: Steering Relief Valve (R10) Pressure, Steering Cylinder Internal Leakage and/or Gear Pump (P2) Flow Tests.

Traction Circuit Relief Valve (R3) and (R4) Pressure Test

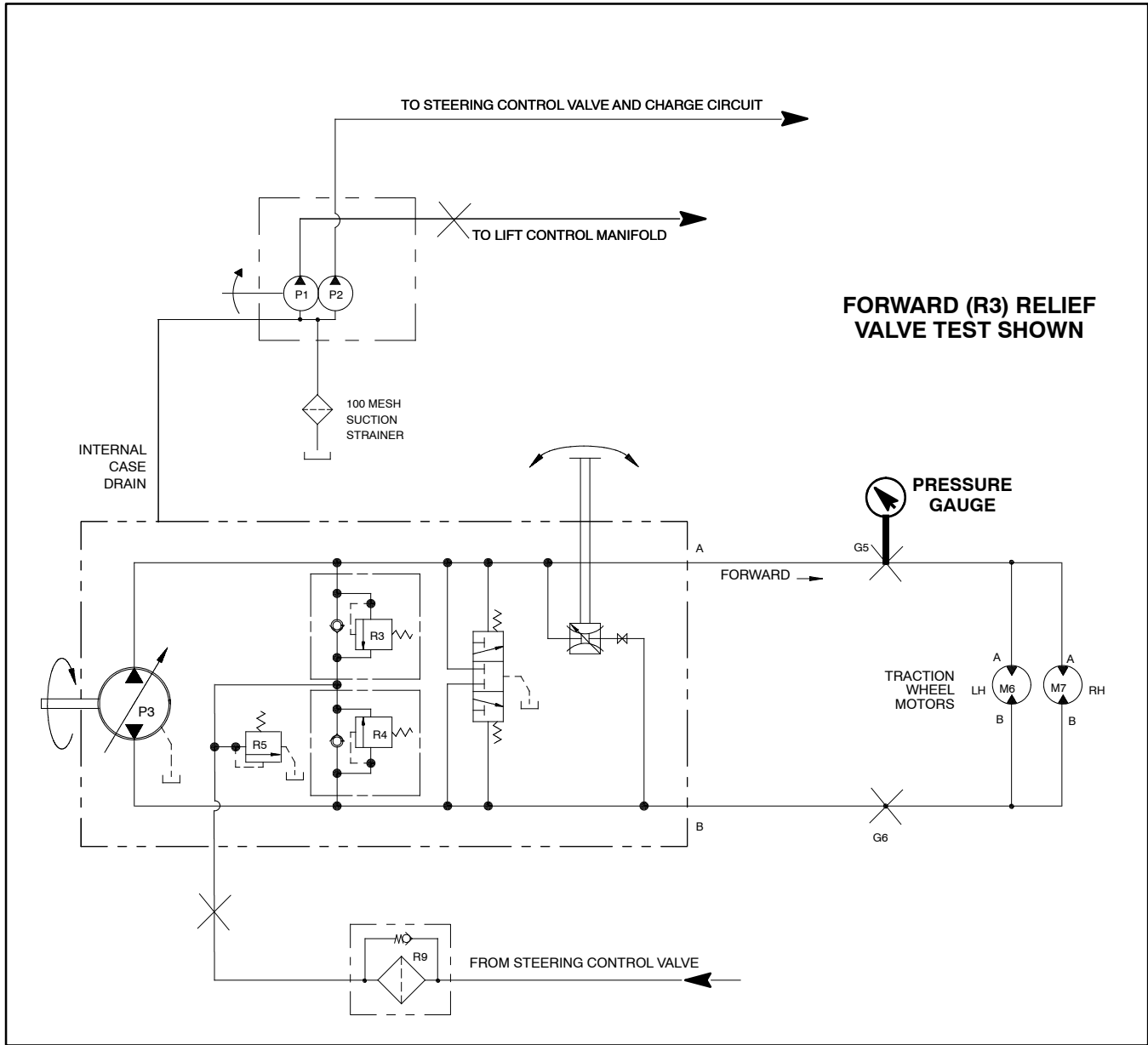


Figure 26

The traction circuit relief pressure test should be performed to make sure that forward and reverse traction circuit relief pressures are correct.

Procedure for Traction Circuit Relief Valve (R3) and (R4) Pressure Test

1. Drive machine to an open area. Park machine on a level surface with the cutting units lowered and disengaged. Make sure engine is off. Apply the parking brake.
2. Read Precautions For Hydraulic Testing at the beginning of this section.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See **Relieving Hydraulic System Pressure** in the General Information section of this chapter.

NOTE: If machine is equipped with optional CrossTrax™ AWD, reverse relief pressure test ports are located on CrossTrax™ hydraulic manifold.

3. Thoroughly clean traction circuit test port on hydraulic tube for direction to be checked (Fig. 27). Connect a 5000 PSI (350 bar) pressure gauge to test port.

4. After installing tester, start engine and run at low idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.

5. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.

6. Sit on seat and increase engine speed to high idle speed (**3000 RPM**).

7. Apply brakes and slowly depress the traction pedal in the direction to be tested (forward or reverse). While pushing traction pedal down, carefully watch the pressure gauge needle. As the traction relief valve lifts, the gauge needle will momentarily stop. Traction system pressure as the relief valve opens should be:

Approximately 3625 PSI (250 bar) in both forward (R3) and reverse (R4)

NOTE: If traction pedal continues to be pressed after the relief valve has opened, system pressure may increase higher than relief pressure.

8. When relief pressure has been identified, release traction pedal, stop engine and record test results.

NOTE: Forward (R3) and reverse (R4) relief valves are identical. Relief valves can be switched in piston (traction) pump to help in identifying a faulty relief valve.

9. If traction pressure problem occurs in one direction only, interchange the relief valves in the piston (traction) pump (Fig. 28) to see if the problem changes to the other direction. Clean or replace valves as necessary. These cartridge type valves are factory set, and are not adjustable. If traction relief pressure is low and relief valves are in good condition, piston (traction) pump and/or wheel motors should be suspected of wear and inefficiency.

10. After testing is completed, make sure that engine is stopped and then relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section of this chapter). Remove pressure gauge from machine and install dust cap to test port.

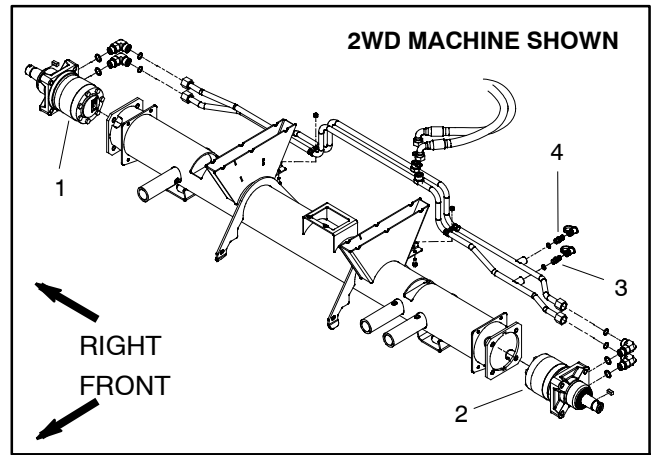


Figure 27

- 1. RH wheel motor
- 2. LH wheel motor
- 3. Forward test port
- 4. Reverse test port

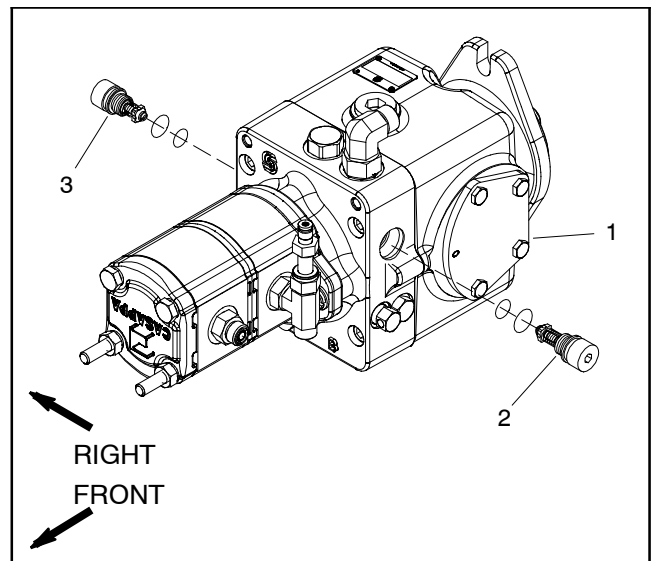


Figure 28

- 1. Piston (traction) pump
- 2. Reverse relief valve (R4)
- 3. Forward relief valve (R3)

Hydraulic System

Traction Circuit Charge Pressure Test

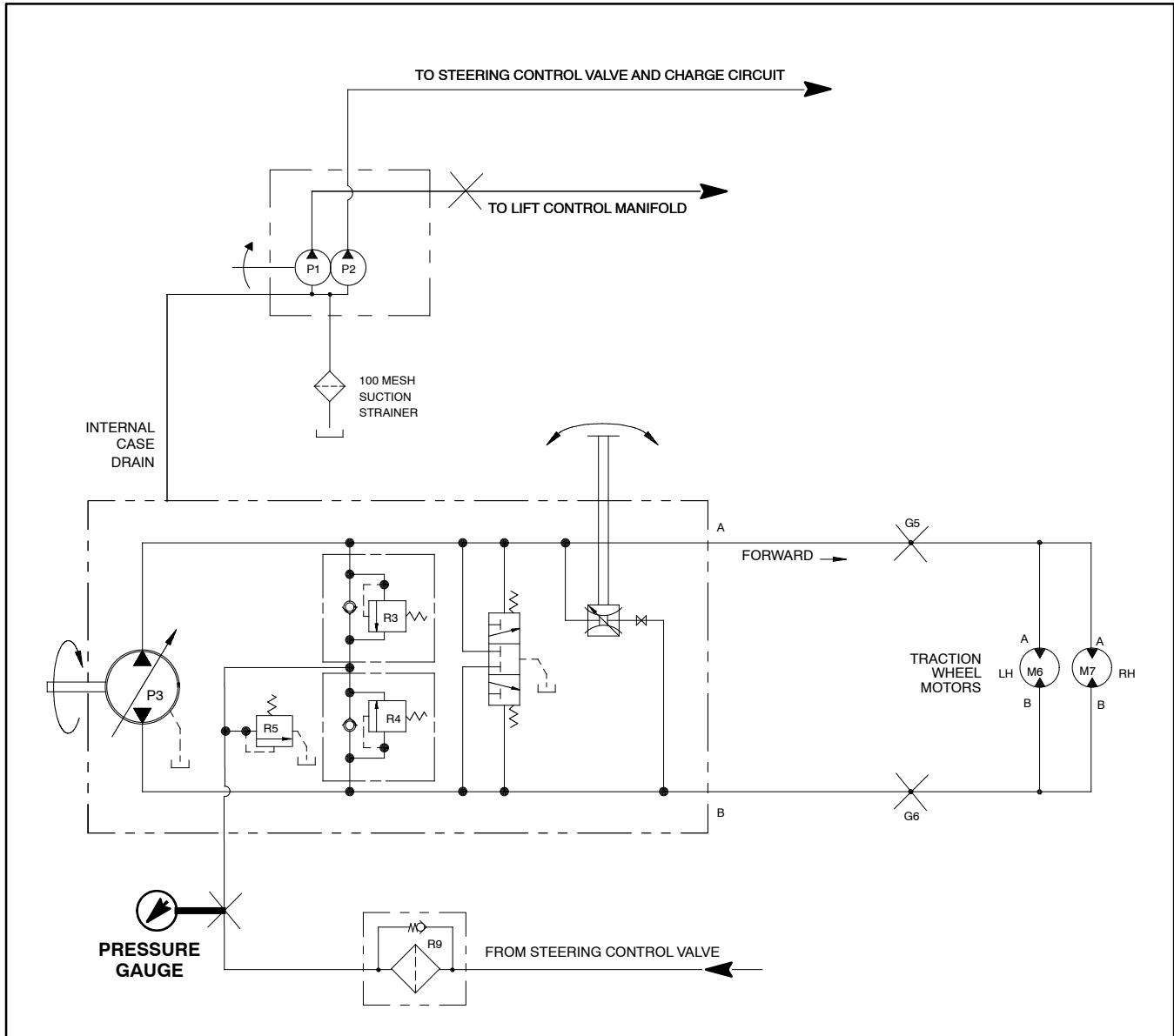


Figure 29

The traction circuit charge pressure test should be performed to make sure that the traction charge circuit is functioning correctly.

Procedure for Traction Circuit Charge Pressure Test

1. Park machine on a level surface with the cutting units lowered and disengaged. Make sure engine is off. Apply the parking brake.
2. Read Precautions For Hydraulic Testing in this section.
3. Raise and support operator seat to allow access to hydraulic pump assembly.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

4. Thoroughly clean test port on hydraulic tube between piston (traction) pump and oil filter (Fig. 30). Connect a 1000 PSI (70 bar) pressure gauge to test port.

5. Start engine and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.

6. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.

7. Make sure that traction pedal is in neutral, the steering wheel is stationary and parking brake is engaged.

8. Increase engine speed to high idle speed (**3000 RPM**) and monitor pressure gauge to determine no load charge pressure. Record test results.

GAUGE READING TO BE approximately 200 to 250 PSI (13.8 to 17.2 bar)

9. Next, determine charge pressure under traction load by operating the machine in a direct forward and reverse direction (not steering). Make sure that engine is running at full speed (**3000 RPM**). Apply the brakes and press the traction pedal in the forward direction and then to reverse while monitoring the pressure gauge. Stop engine and record test results.

GAUGE READING TO BE approximately 150 to 250 PSI (13.8 to 17.2 bar)

10. Compare measured charge pressure from step 8 with pressure from step 9:

A. If charge pressure is good under no load (step 8), but drops below specification when under traction load (step 9), the piston (traction) pump should be suspected of wear and inefficiency. When the pump is worn or damaged, the charge system is not able to replenish lost traction circuit oil due to excessive leakage in the worn pump.

B. If there is no charge pressure, or pressure is low, check for restriction in gear pump intake line. Inspect charge relief valve and valve seat in the piston (traction) pump (see Piston (Traction) Pump Service in the Service and Repairs section of this chapter). Also, consider a worn or damaged gear pump section (P2) (see Gear Pump Flow Test in this section).

NOTE: If gear pump (P2) is worn or damaged, both charge circuit and steering circuit will be affected.

11. After charge pressure testing is completed, make sure that engine is not running and then relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section of this chapter). Remove pressure gauge from test port and install dust cap to test port.

12. Lower and secure operator seat.

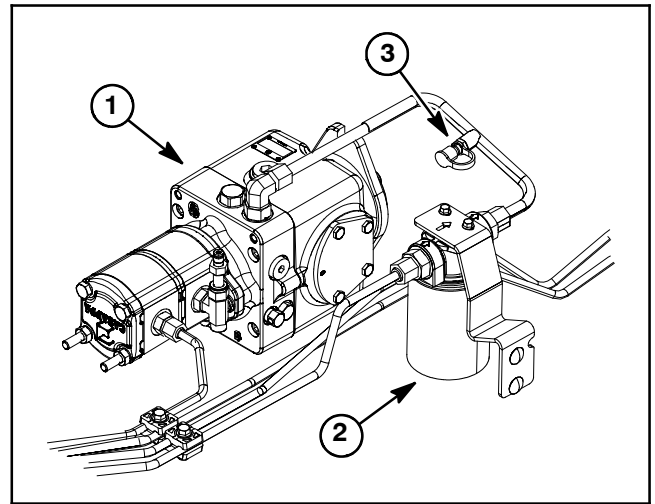


Figure 30

- | | |
|---------------------------|-----------------|
| 1. Piston (traction) pump | 3. Test fitting |
| 2. Oil filter | |

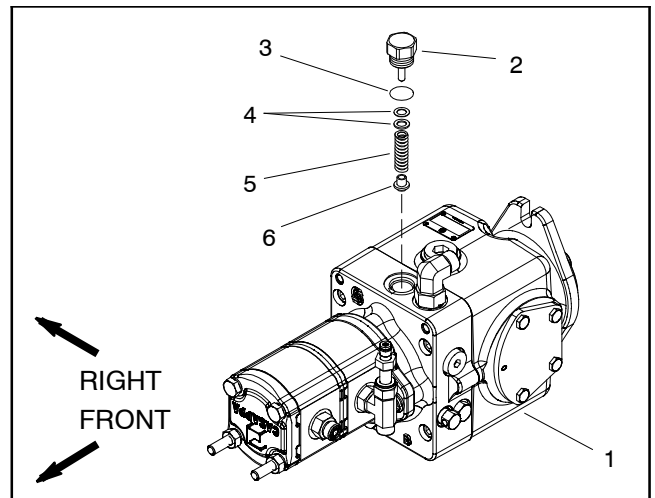


Figure 31

- | | |
|---------------------------|-------------------------|
| 1. Piston (traction) pump | 4. Shim kit |
| 2. Plug | 5. Spring |
| 3. O-ring | 6. Charge relief poppet |

Gear Pump (P2) Flow Test (Using Tester with Pressure Gauges and Flow Meter)

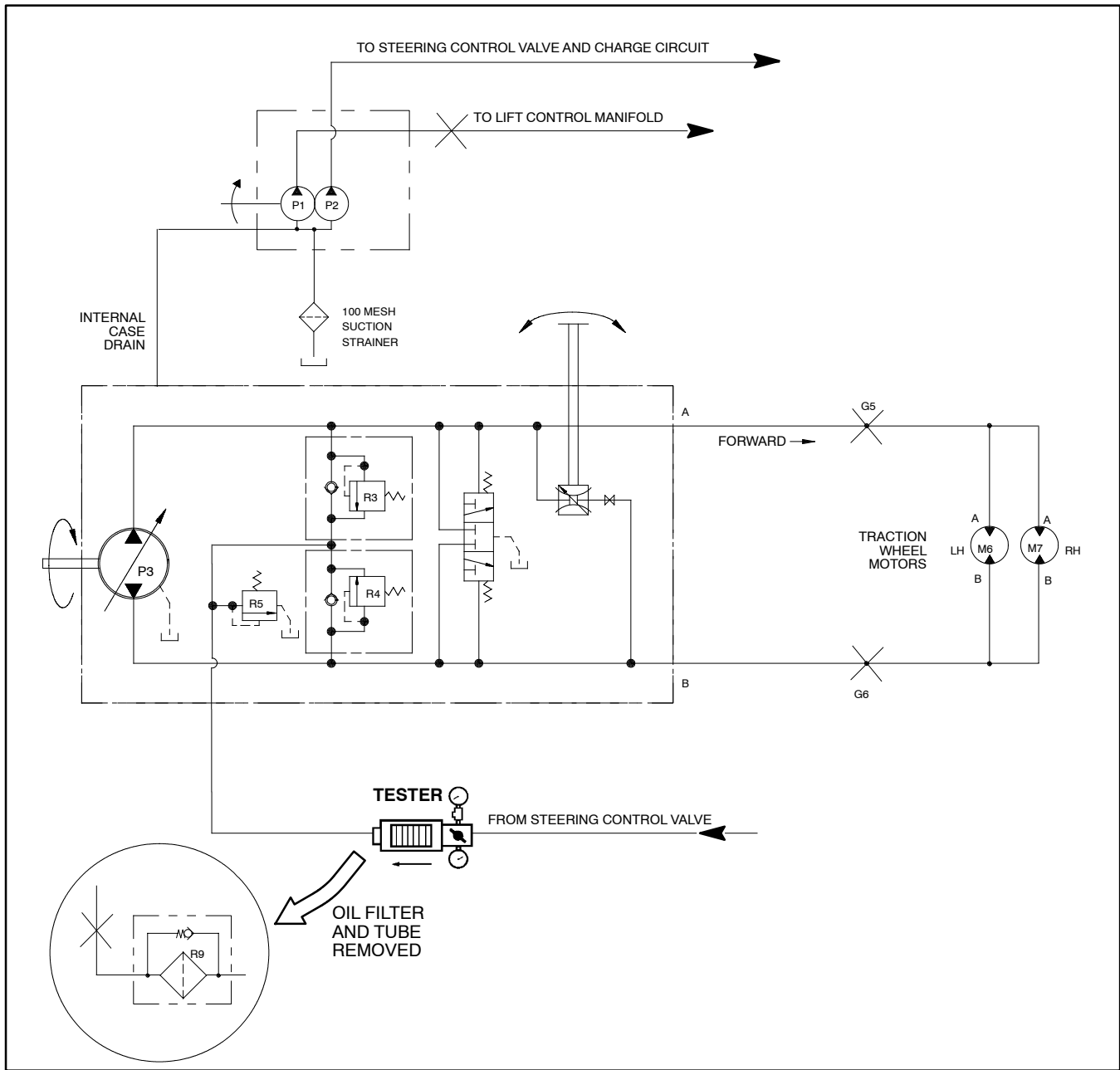



Figure 32

The gear pump (P2) flow test should be performed to make sure that the traction charge circuit and steering circuit have adequate hydraulic flow.

Procedure for Gear Pump (P2) Flow Test

1. Park machine on a level surface with the cutting units lowered and disengaged. Make sure engine is off. Apply the parking brake.
2. Read Precautions For Hydraulic Testing in this section.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

3. Raise and prop operator seat to allow access to hydraulic pump assembly.

4. Thoroughly clean the ends of the hydraulic tubes connected to the oil filter and piston pump inlets (Fig. 33). Disconnect hydraulic tubes from oil filter inlet and piston pump inlet. Remove two (2) flange head screws that secure oil filter adapter to frame. Remove oil filter assembly and hydraulic tube from machine.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow meter is showing that the oil will flow from the hydraulic tube, through the tester and into the piston (traction) pump.

5. Install tester with pressure gauge and flow meter in place of the removed oil filter assembly and hydraulic tube (Fig. 34). Connect tester inlet hose to the hydraulic tube. Connect the tester outlet hose to the piston (traction) pump fitting. **Make sure the flow control valve on tester is fully open.**

6. Make sure that the traction pedal is in neutral, the steering wheel is stationary and the parking brake is engaged.

7. Start engine and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.

8. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.

9. Increase engine speed to high idle speed (**3000 RPM**). Use InfoCenter Display to verify that engine speed is correct.

IMPORTANT: The gear pump is a positive displacement type. If pump flow is completely restricted or stopped, damage to the pump, tester or other components could occur.

10. While watching tester pressure gauge, slowly close the tester flow control valve until **800 PSI (55 bar)** is obtained on gauge.

FLOW TESTER READING TO BE: A pump in good condition should have a flow of approximately **4.7 GPM (17.8 LPM)** at **800 PSI (55 bar)**.

11. Open the tester flow control valve, stop engine and record test results.

12. If flow is less than **4 GPM (15.1 LPM)** or a pressure of **800 PSI (55 bar)** cannot be obtained, consider that a gear pump problem exists. Check for restriction in pump intake line. If intake is not restricted, remove gear pump and repair or replace pump as necessary (see Hydraulic Pump Assembly and Gear Pump Service in the Service and Repairs section of this chapter).

NOTE: If the flow from gear pump (P2) is low, the operation of both the charge circuit and the steering circuit will be affected.

13. After testing is completed, make sure that engine is stopped, then relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section of this chapter). Remove hydraulic tester from hydraulic tube and pump fitting. Install oil filter assembly and then connect removed hydraulic tube to oil filter and piston pump fitting.

14. Lower and secure operator seat.

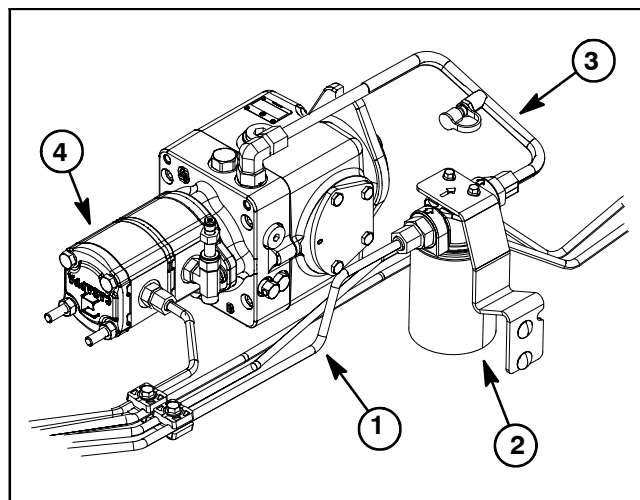


Figure 33

- 1. Hydraulic tube
- 2. Oil filter
- 3. Hydraulic tube
- 4. Gear Pump (P2)

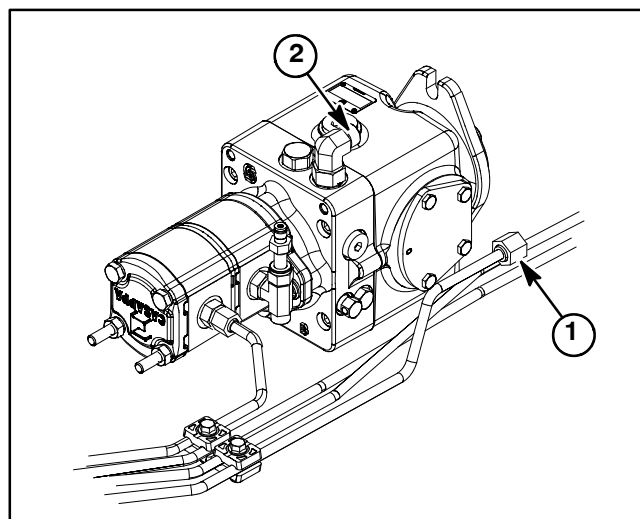


Figure 34

- 1. Tester inlet connection
- 2. Tester outlet connection

Front Wheel Motor Efficiency Test

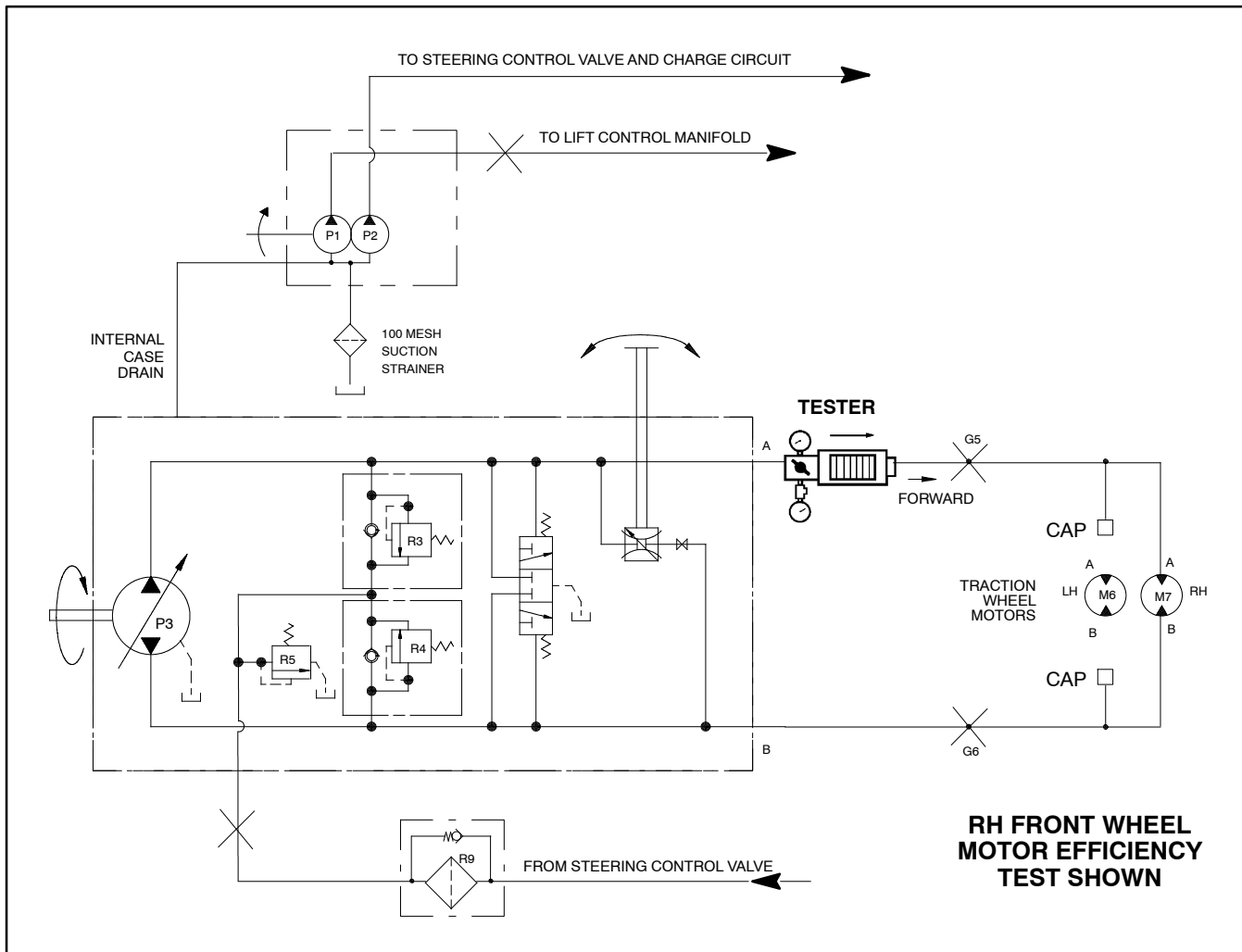


Figure 35

Procedure for Front Wheel Motor Efficiency Test

NOTE: Over a period of time, a wheel motor can wear internally. A worn motor may by-pass oil causing the motor to be less efficient. Eventually, enough oil loss will cause the wheel motor to stall under heavy load conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system and affect overall machine performance.

IMPORTANT: Refer to **Traction Circuit Component Failure in the General Information section** for information regarding the importance of removing contamination from the traction circuit.

NOTE: This test procedure includes steps to test both front wheel efficiency together before testing individual wheel motors.

1. Make sure that traction pedal is adjusted to the neutral position (see Traction Unit Operator's Manual).

Hydraulic System

2. Drive machine to an open area. Park machine on a level surface with the cutting units lowered and disengaged. Make sure engine is off.

3. Read Precautions For Hydraulic Testing in this section.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

4. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.

5. Chock front wheels to prevent wheel rotation.

NOTE: If machine is equipped with optional CrossTrax™ AWD, jack up and support the rear wheels off the ground to allow flow through the rear wheel motors.

6. Thoroughly clean junction of hydraulic hose and **right** side elbow fitting on bottom of piston (traction) pump (Fig. 36). Disconnect hose from piston (traction) pump fitting.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow meter is showing that the oil will flow from the pump, through the tester and into the hydraulic hose.

7. Install tester with pressure gauges and flow meter in series with the piston (traction) pump and the disconnected hose. **Make sure the tester flow control valve is fully open.**

8. Start engine and increase engine speed to high idle speed (**3000 RPM**). Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.

	CAUTION
Use extreme caution when performing test. The front tires on the ground will be trying to move the machine forward.	

9. Fully apply the brakes to prevent the front wheels from rotating and slowly push traction pedal in **forward** direction until **1000 PSI** is displayed on the tester pressure gauge.

10. Combined front wheel motor internal leakage will be shown on flow meter in GPM (LPM).

11. Release traction pedal, release brake pedal, shut engine off, rotate both front wheels and retest. Testing of wheel motor leakage in three (3) different wheel positions will provide the most accurate test results. Record measured front wheel motor internal leakage for all three (3) wheel positions.

12. If combined leakage for the front wheel motors is **less than 1.5 GPM (5.7 LPM)**, consider that the front wheel motors are in good condition. If combined leakage for the front wheel motors is **more than 1.5 GPM (5.7 LPM)**, one or both of the motors may be faulty. Individual front wheel motor testing is necessary.

13. To test individual front wheel motors:

A. Remove front wheel from wheel motor that is **not** being tested. Remove wheel shield to allow access to hydraulic tubes and fittings on wheel motor. Remove fasteners that secure front hydraulic tube r-clamps to frame.

B. On the front wheel motor that is **not** being tested, thoroughly clean junction of both hydraulic tubes and wheel motor fittings. Disconnect both hydraulic lines from wheel motor that is **not** being tested. Install a steel cap on disconnected hydraulic lines and wheel motor fittings.

C. Use the procedure described in steps 8 to 10 above to identify individual front wheel motor leakage. Individual motor internal leakage will be shown on flow meter in GPM (LPM). Flow should be **less than 1.5 GPM (5.7 LPM)** for the tested wheel motor. If leakage for the tested motor is **more than 1.5 GPM (5.7 LPM)**, the tested motor is faulty.

D. If other front wheel motor requires testing, complete steps A, B and C for remaining wheel motor.

14. After testing is completed, stop engine and then relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section of this chapter). Disconnect tester from hydraulic fitting and hose. Connect hose to pump elbow fitting. Remove caps from hydraulic tubes and reconnect tubes to wheel motor. Secure hydraulic tubes to machine with r-clamps and removed fasteners. Install wheel shield and wheel(s) (see Wheels in the Service and Repairs section of Chapter 6 - Chassis).

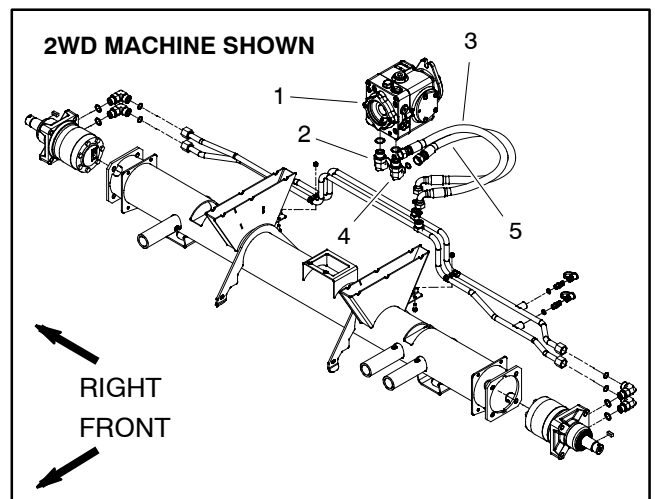


Figure 36

- | | |
|---------------------------|-----------------------|
| 1. Piston (traction) pump | 4. LH elbow fitting |
| 2. RH elbow fitting | 5. Hyd hose (reverse) |
| 3. Hyd hose (forward) | |

Piston (Traction) Pump Flow Test (Using Tester with Flow Meter and Pressure Gauge)

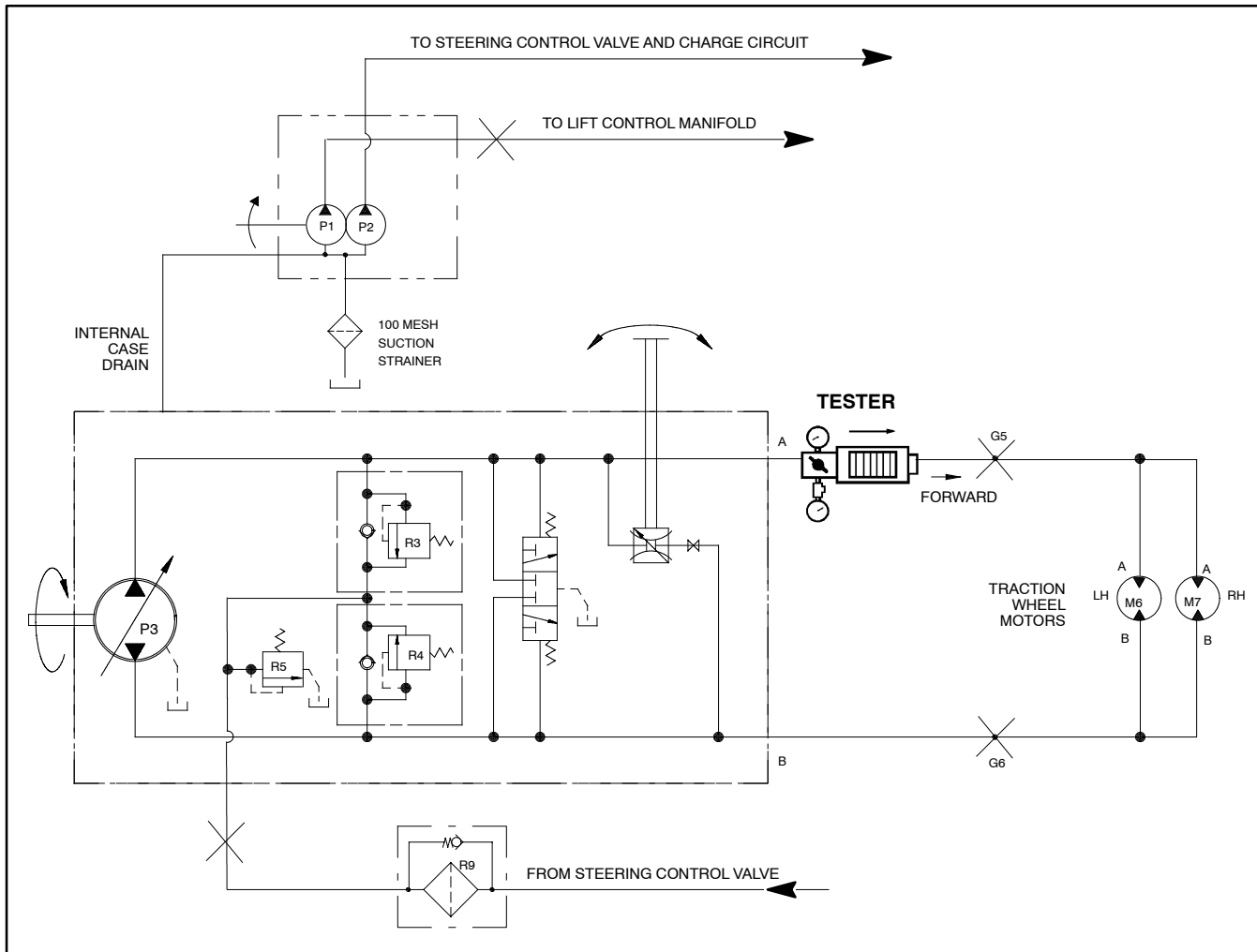


Figure 37

Procedure for Piston (Traction) Pump Flow Test

This test measures piston (traction) pump output (flow). During this test, pump load is created at the flow meter using the adjustable load valve on the tester.

IMPORTANT: Traction circuit flow for your Reelmaster is approximately 30 GPM (113.5 LPM). Use 40 GPM Hydraulic Tester #AT40002 (pressure and flow) for this test (see Special Tools in this chapter).

1. Park machine on a level surface with the cutting units lowered and disengaged. Make sure engine is off. Apply the parking brake. Make sure mow speed limiter is in the transport position to allow full movement of traction pedal.
2. Read Precautions For Hydraulic Testing in this section.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

3. Make sure that traction pedal is adjusted to the neutral position. Also, ensure that piston (traction) pump is at full stroke when traction pedal is pushed into fully forward position.
4. Raise and support machine so all wheels are off the ground (see Jacking Instructions in Chapter 1 - Safety).

5. Thoroughly clean junction of hydraulic hose and **right** side fitting on bottom of piston (traction) pump (Fig. 38). Disconnect hose from right side pump fitting.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow meter is showing that the oil will flow from the pump, through the tester and into the disconnected hydraulic hose.

6. Install tester with pressure gauge and flow meter in series between piston pump fitting and disconnected hose to allow flow from piston pump to tester. Use hydraulic hose kit (see Special Tools in this chapter) to connect tester to machine. Make sure that fitting and hose connections are properly tightened. Also, make sure the flow control valve on tester is fully open.

**CAUTION**

Drive wheels will be off the ground and rotating during this test. Make sure machine is supported so it will not move and accidentally fall to prevent injuring anyone near the machine.

7. Start engine and run at idle speed. Check for any hydraulic leakage from tester and hose connections. Correct any leaks before proceeding.

8. Increase engine speed to high idle speed (**3000 RPM**). Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes. Make sure the hydraulic reservoir is full.

9. Slowly push traction pedal to fully forward position. Keep pedal fully depressed in the forward position during the flow test.

10. Have second person watch pressure gauge on tester carefully while slowly closing the tester flow control valve until **1000 PSI (69 bar)** is obtained. Verify with the InfoCenter Display that the **engine speed** is still **3000 RPM**.

11. Observe flow gauge. For a piston pump in good condition, flow indication should be approximately **26 GPM (98 LPM)**.

12. Open flow control valve on tester, release traction pedal to the neutral position and shut off engine. Record test results.

13. If measured flow is less than **23 GPM (87 LPM)**, consider the following:

A. The piston (traction) pump swash plate is not being rotated fully (e.g. traction pedal linkage may need adjustment, mow speed limiter is not in the transport position).

B. The piston (traction) pump needs to be repaired or replaced as necessary.

C. Make necessary repairs before performing additional hydraulic tests on the traction system.

14. When testing is complete, disconnect tester and hose kit from pump fitting and machine hydraulic hose. Reconnect hose to pump fitting.

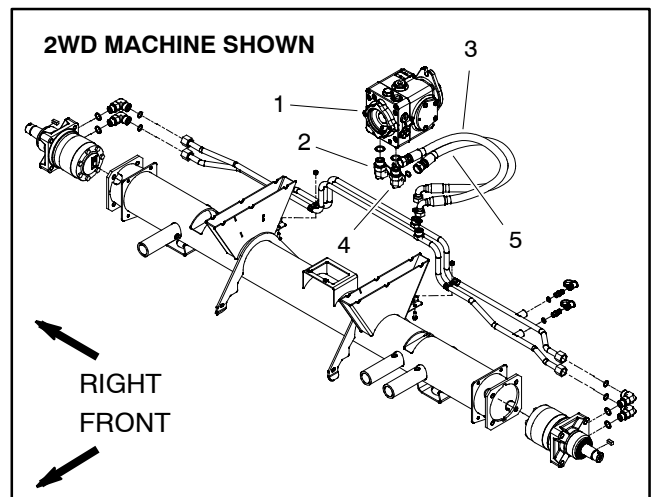


Figure 38

- | | |
|---------------------------|-----------------------|
| 1. Piston (traction) pump | 4. LH elbow fitting |
| 2. RH elbow fitting | 5. Hyd hose (reverse) |
| 3. Hyd hose (forward) | |

Lift Relief Valve (SVRV) Pressure Test

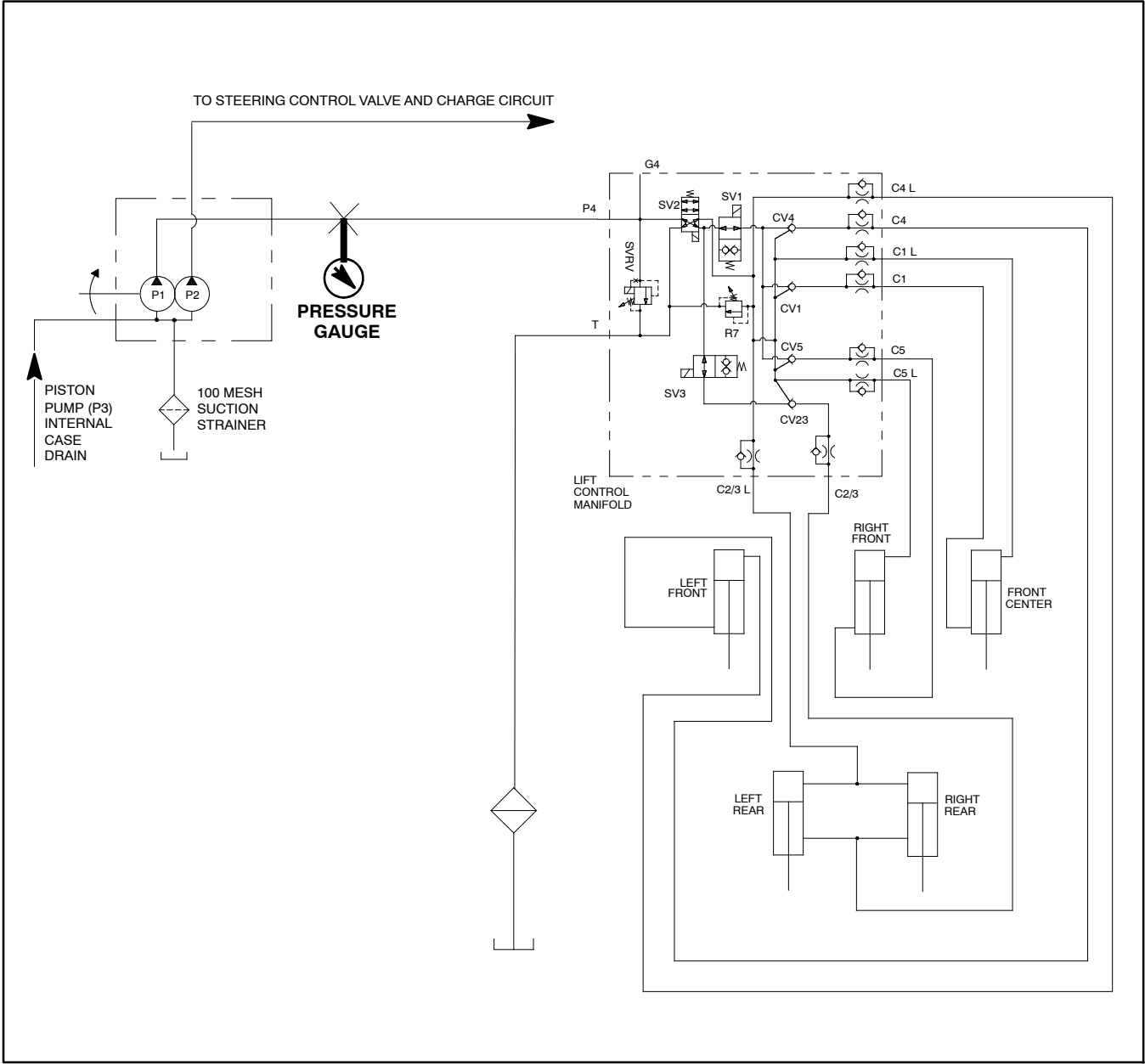



Figure 39

The lift relief valve (SVRV) pressure test should be performed to make sure that the lift circuit relief pressure is correct.

Procedure for Lift Relief Valve (SVRV) Pressure Test

1. Park machine on a level surface with the cutting units lowered and disengaged. Make sure engine is off. Apply the parking brake.
2. Read Precautions For Hydraulic Testing in this section.

**CAUTION**

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

3. Raise and support operator seat to allow access to hydraulic pump assembly.
4. Thoroughly clean test port attached to tee fitting on 1st gear pump section (P1) (Fig. 40). Connect a 5000 PSI (350 bar) pressure gauge to test port.
5. After installing pressure gauge to test port, start engine and run at low idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
6. Increase engine speed to high idle speed (**3000 RPM**). Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.

IMPORTANT: Do not allow circuit pressure to exceed 2500 PSI (172 bar).

IMPORTANT: While performing this test, hold lower mow/raise lever in the raise position only long enough to get a system pressure reading. Holding the lever in raise for an extended period may damage system components.

7. Make sure that reel engage/disengage switch is OFF and then pull lower mow/raise lever rearward (raise position) to pressurize lift circuit. While holding lever rearward, watch pressure gauge carefully. As the cutting units raise fully and the lift relief valve lifts, system pressure should be:

Approximately 2000 PSI (138 bar)

8. Once relief pressure has been determined, return the lower mow/raise lever to the neutral position and stop the engine.

9. If measured pressure is incorrect, remove solenoid relief valve (SVRV) in lift control manifold and clean or replace valve (see Lift Control Manifold Service in the Service and Repairs section of this chapter). Also, if pressure is low, check for restriction in gear pump suction hose. Internal lift cylinder leakage in one or more cylinders would also cause low lift circuit pressure (see Lift Cylinder Internal Leakage Test in this section). Gear pump section (P1) could also be suspected of wear, damage or inefficiency (see Gear Pump (P1) Flow Test in this section).

10. After lift relief valve pressure testing is completed, make sure that engine is stopped, then relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section of this chapter). Disconnect pressure gauge from test port at gear pump and install dust cap to test port.

11. Lower and secure operator seat.

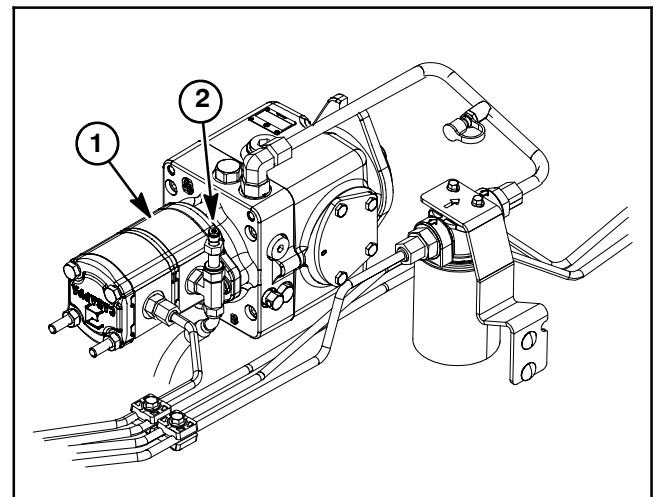


Figure 40

1. 1st gear pump section 2. Test port

**Gear Pump (P1) Flow Test
(Using Tester with Pressure Gauges and Flow Meter)**

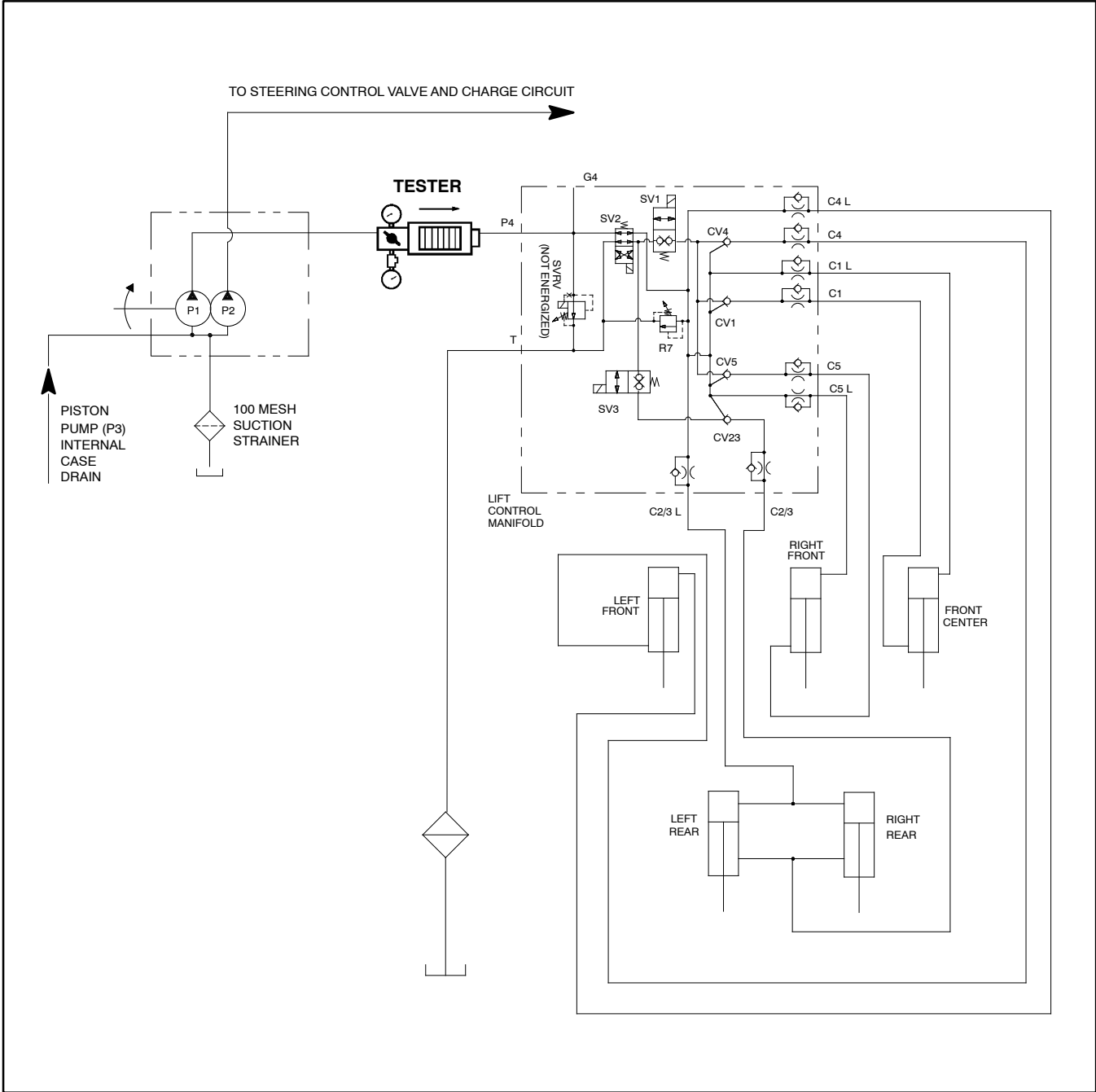


Figure 41

The gear pump section (P1) flow test should be performed to make sure that the cutting unit lift circuit has adequate hydraulic flow.

Procedure for Gear Pump (P1) Flow Test

1. Park machine on a level surface with the cutting units lowered and disengaged. Make sure engine is off. Apply the parking brake.
2. Read Precautions For Hydraulic Testing in this section.



3. Raise and prop operator seat to allow access to hydraulic pump assembly.
4. Thoroughly clean junction of hydraulic hose and tee fitting on left side of 1st gear pump section (Fig. 42). Disconnect hose from left side pump fitting.

IMPORTANT: Make sure that the oil flow indicator arrow on the flow meter is showing that the oil will flow from the 1st pump section (P1), through the tester and to the hydraulic hose.

5. Install tester with pressure gauge and flow meter between gear pump fitting and disconnected hose to allow flow from gear pump section to tester. Connect tester inlet hose to the pump fitting. Connect the tester outlet hose to the disconnected hydraulic hose. **Make sure the flow control valve on tester is fully open.**
6. Make sure that the traction pedal is in neutral and the parking brake is engaged.
7. Start engine and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
8. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.
9. Increase engine speed to high idle speed (**3000 RPM**). Use the InfoCenter Display to verify that engine speed is correct.

IMPORTANT: The gear pump is a positive displacement type. If pump flow is completely restricted or stopped, damage to the pump, tester or other components could occur.

10. While carefully watching pressure gauge on tester, slowly close the tester flow control valve until **1000 PSI (69 bar)** is obtained on gauge. Make sure that engine speed is still correct.

FLOW TESTER READING TO BE: A pump in good condition should have a flow of approximately **3 GPM (11.4 LPM)** at **1000 PSI (69 bar)**.

11. Once the gear pump flow has been determined, open the tester flow control valve, stop engine and record test results.

12. If flow is less than **2.5 GPM (9.6 LPM)** or a pressure of **1000 PSI (69 bar)** cannot be obtained, consider that a gear pump problem exists. Check for restriction in gear pump suction hose. If intake is not restricted, remove gear pump and repair or replace pump as necessary (see Hydraulic Pump Assembly and Gear Pump Service in the Service and Repairs section of this chapter).

NOTE: If the flow from the 1st gear pump section (P1) is low, the operation of all lift cylinders will be affected.

13. After testing is completed, make sure that engine is stopped, then relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section of this chapter). Disconnect tester from gear pump tee fitting and hydraulic hose. Reconnect machine hose to pump fitting.

14. Lower and secure operator seat.

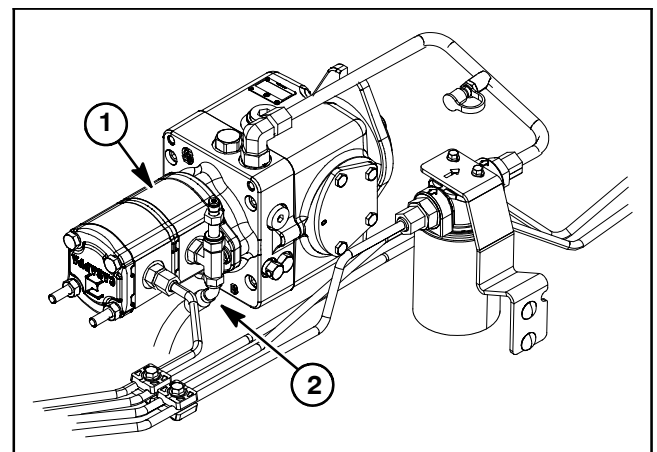


Figure 42

1. 1st gear pump section
2. Hydraulic hose

Lift Cylinder Internal Leakage Test

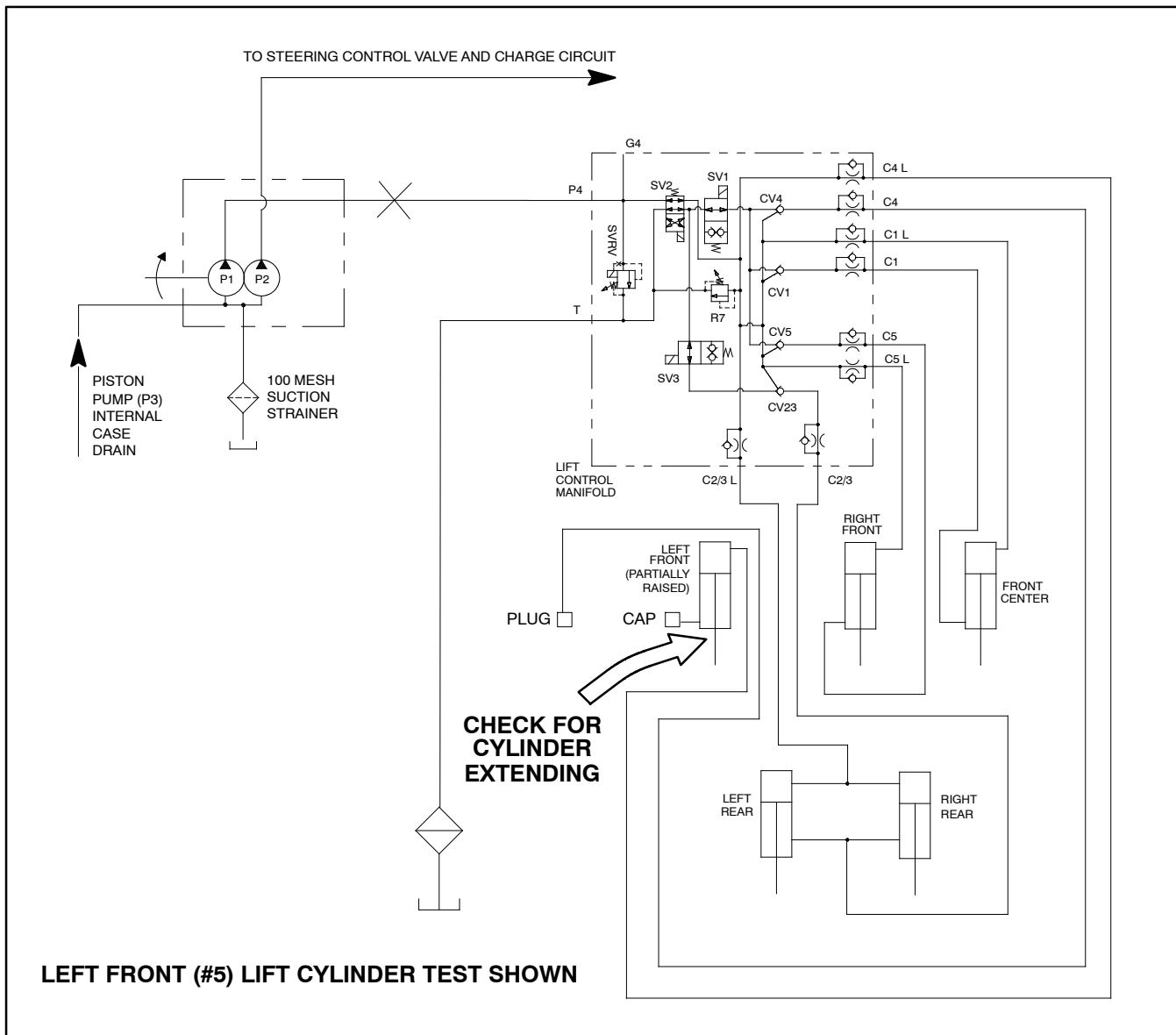


Figure 43

The lift cylinder internal leakage test should be performed if a cutting unit raise and lower problem is identified. This test will determine if a lift cylinder is faulty.

NOTE: Cutting unit raise/lower circuit operation will be affected by lift cylinder binding, extra weight on the cutting units and/or binding of lift components. Make sure that these items are checked before proceeding with lift cylinder internal leakage test.

Procedure for Lift Cylinder Internal Leakage Test:

1. Park machine on a level surface with the cutting units disengaged and in the turn-around position. Turn the engine off and apply the parking brake.

2. Read Precautions For Hydraulic Testing in this section.

3. For the lift cylinder that is to be tested, use a jack to raise the lift arm slightly. This will remove the load from the lift cylinder and relieve lift cylinder hydraulic pressure. Leave the jack under the lift arm to support the lift arm and to prevent the lift arm from lowering.

NOTE: If either of the rear lift cylinders is being tested, both rear lift arms need to be supported.

4. Thoroughly clean the area around the end of the hydraulic hose at the rod end of the lift cylinder for the supported lift arm. Disconnect the hydraulic hose from the lift cylinder rod end fitting (Fig. 44).

IMPORTANT: When capping lift cylinder fitting and hydraulic hose end, use a steel cap and plug to ensure that fluid leakage will not occur. Plastic plugs will not hold hydraulic pressure that will be developed during this test procedure.

5. Place a steel cap on the open lift cylinder fitting to seal the lift cylinder. Also, install a steel plug in the open end of the disconnected hose to prevent leakage or contamination.

6. Slowly lower the jack and remove it from under the lift arm. The cutting unit should settle slightly and then be supported by the capped lift cylinder.

7. Mark the position of the lift cylinder rod at the lift cylinder head with a piece of tape (Fig. 45).

8. Leave the machine parked for two (2) hours and monitor the lift cylinder. The weight of the cutting unit may cause the lift cylinder to gradually extend. Use the tape location to determine lift cylinder rod movement (Fig. 46).

A. If lift cylinder rod movement is less than 1.250" (31.7 mm) after two (2) hours, make sure that the cutting unit has not settled to the ground. If the cutting unit is still suspended after two (2) hours and lift cylinder rod movement is less than 1.250" (31.7 mm), consider that the lift cylinder is in good condition. A cylinder in good, usable condition will show minimal movement.

B. Rod movement in excess of 1.250" (31.7 mm) after two (2) hours indicates that the lift cylinder may have internal seal damage or excessive wear. Remove and inspect the lift cylinder (see Lift Cylinder and Lift Cylinder Service in the Service and Repairs section of this chapter).

9. Once lift cylinder condition has been determined, use a jack to raise the lift arm slightly which will remove the load from the lift cylinder. Allow the jack to support the lift arm and to prevent it from lowering. Remove the cap from the cylinder fitting and the plug from the hydraulic hose. Connect the hydraulic hose to the lift cylinder fitting.

10. Remove jack from under the lift arm. Start engine and operate lift cylinders through several up and down cycles. Stop the engine and check for any hydraulic leakage.

11. If needed, repeat steps 3 through 9 for other lift cylinders.

12. After lift cylinder testing is completed, check oil level in hydraulic reservoir and adjust as necessary.

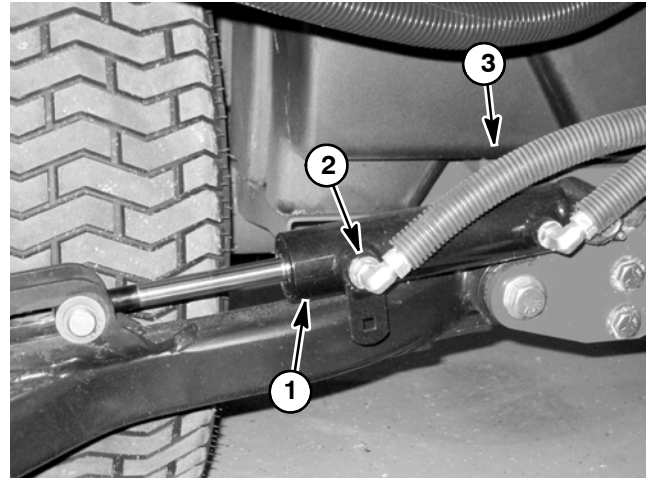


Figure 44

- 1. Lift cylinder (#5 shown)
- 2. Cylinder rod end fitting
- 3. Hydraulic hose

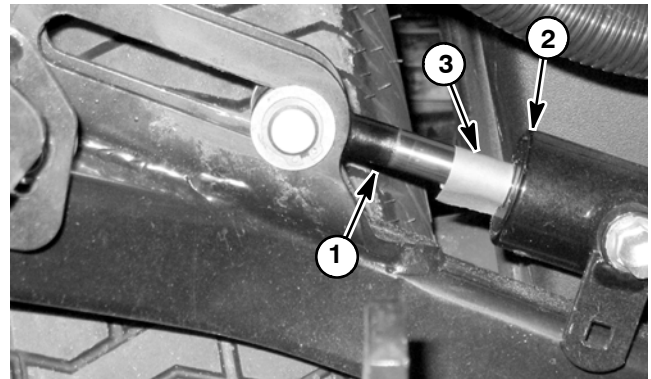


Figure 45

- 1. Lift cylinder rod
- 2. Lift cylinder head
- 3. Tape (initial position)

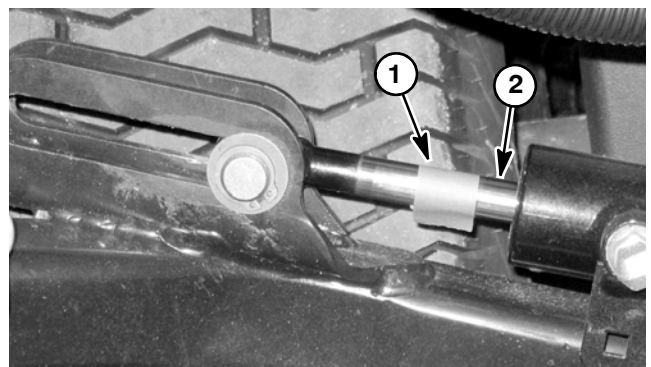


Figure 46

- 1. Tape (after 2 hours)
- 2. Cylinder rod movement

Steering Relief Valve (R10) Pressure Test

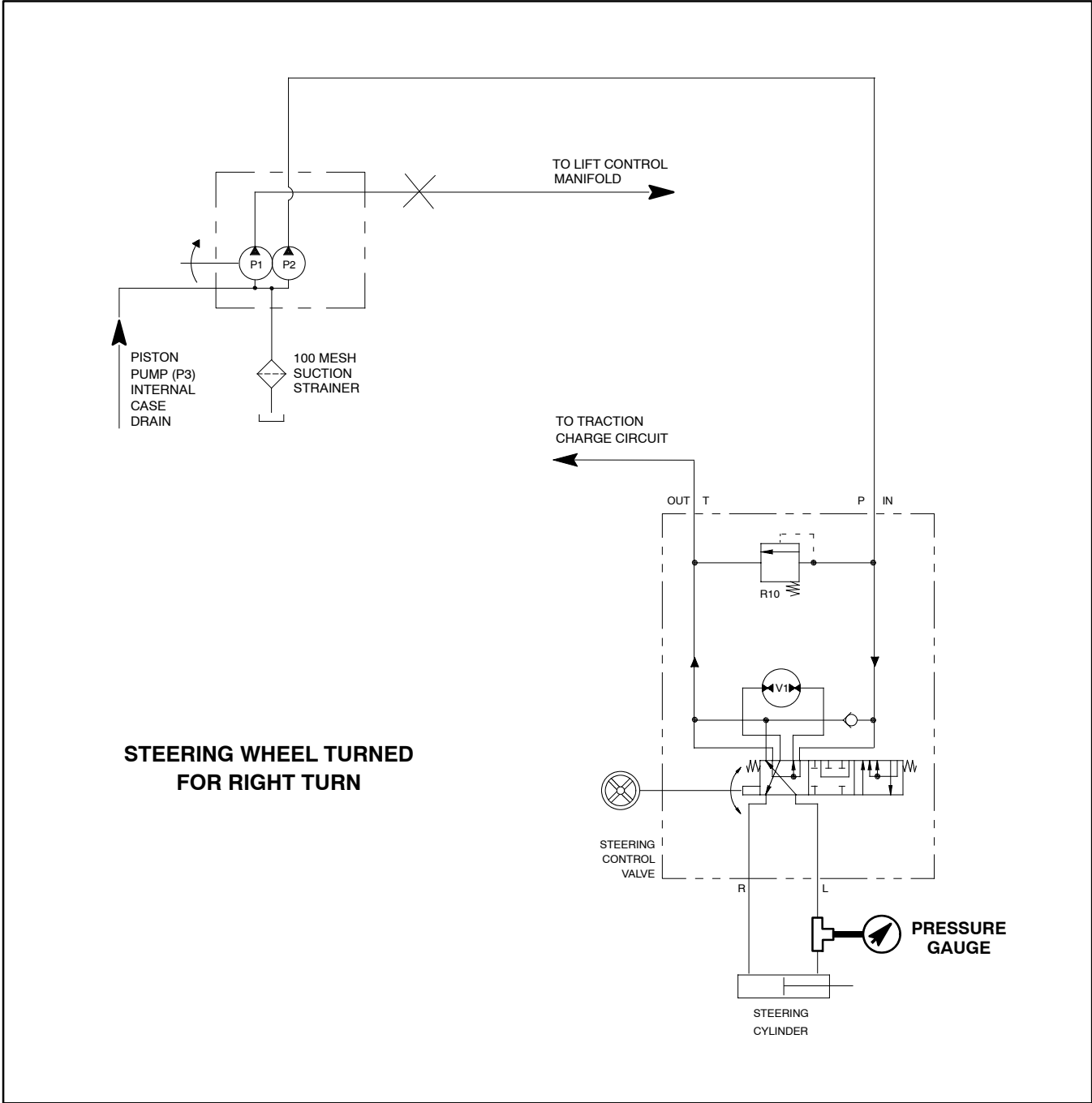



Figure 47

The steering relief valve (R10) pressure test should be performed to make sure that the steering circuit relief pressure is correct.

Procedure for Steering Relief Valve (R10) Pressure Test:

1. Park machine on a level surface with the cutting units lowered and disengaged. Make sure engine is off. Apply the parking brake.
2. Read Precautions For Hydraulic Testing in this section.

	CAUTION
Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.	

3. Thoroughly clean the area around the hydraulic hose at the rod end of the steering cylinder (Fig. 48).
4. Remove hydraulic hose from the fitting on the rod end of the steering cylinder.
5. Install a tee fitting between the disconnected hydraulic hose and the steering cylinder fitting. Install a 5000 PSI (350 bar) pressure gauge to the tee fitting.
6. After installing pressure gauge, start engine and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.
7. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.
8. Increase engine speed to high idle speed (**3000 RPM**).

IMPORTANT: Hold steering wheel at full lock only long enough to get a system pressure reading. Holding the steering wheel against the stop for an extended period may damage the steering control valve.

IMPORTANT: As steering wheel is turned, make sure that pressure gauge is not contacted by any machine parts.

9. Watch pressure gauge carefully while turning the steering wheel for a left hand turn (counter-clockwise) and holding.
10. System pressure should be approximately **1000 PSI (69 bar)** as the relief valve lifts. After determining relief pressure, return steering wheel to the neutral position.
11. Shut off engine. Record test results.

12. If specification is **not** met, repair or replace steering control valve (relief valve in steering control valve is not replaceable). Gear pump section (P2) could also be suspected of wear, damage or inefficiency (see Gear Pump (P2) Flow Test in this section).

NOTE: If the flow from the 2nd gear pump section (P2) is low, the traction charge circuit and steering circuit will both be affected.

13. After steering relief valve testing is completed, make sure that engine is stopped, then relieve hydraulic system pressure (See Relieving Hydraulic System Pressure in the General Information section of this chapter). Remove tee fitting and pressure gauge from hydraulic hose and steering cylinder. Reconnect hydraulic hose to steering cylinder fitting.

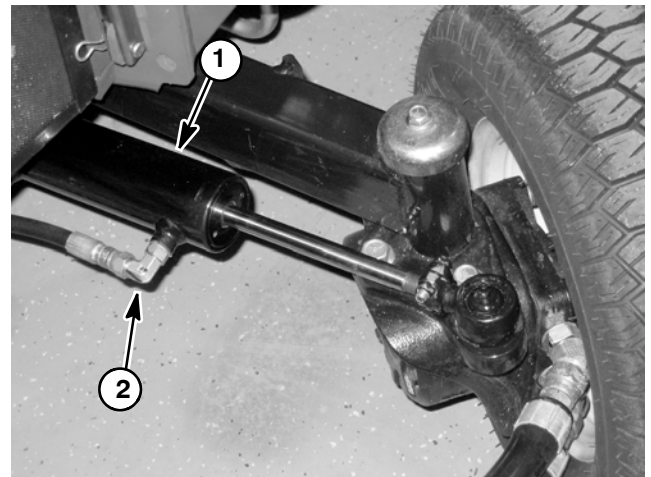


Figure 48

1. Steering cylinder
2. Rod end fitting

Steering Cylinder Internal Leakage Test

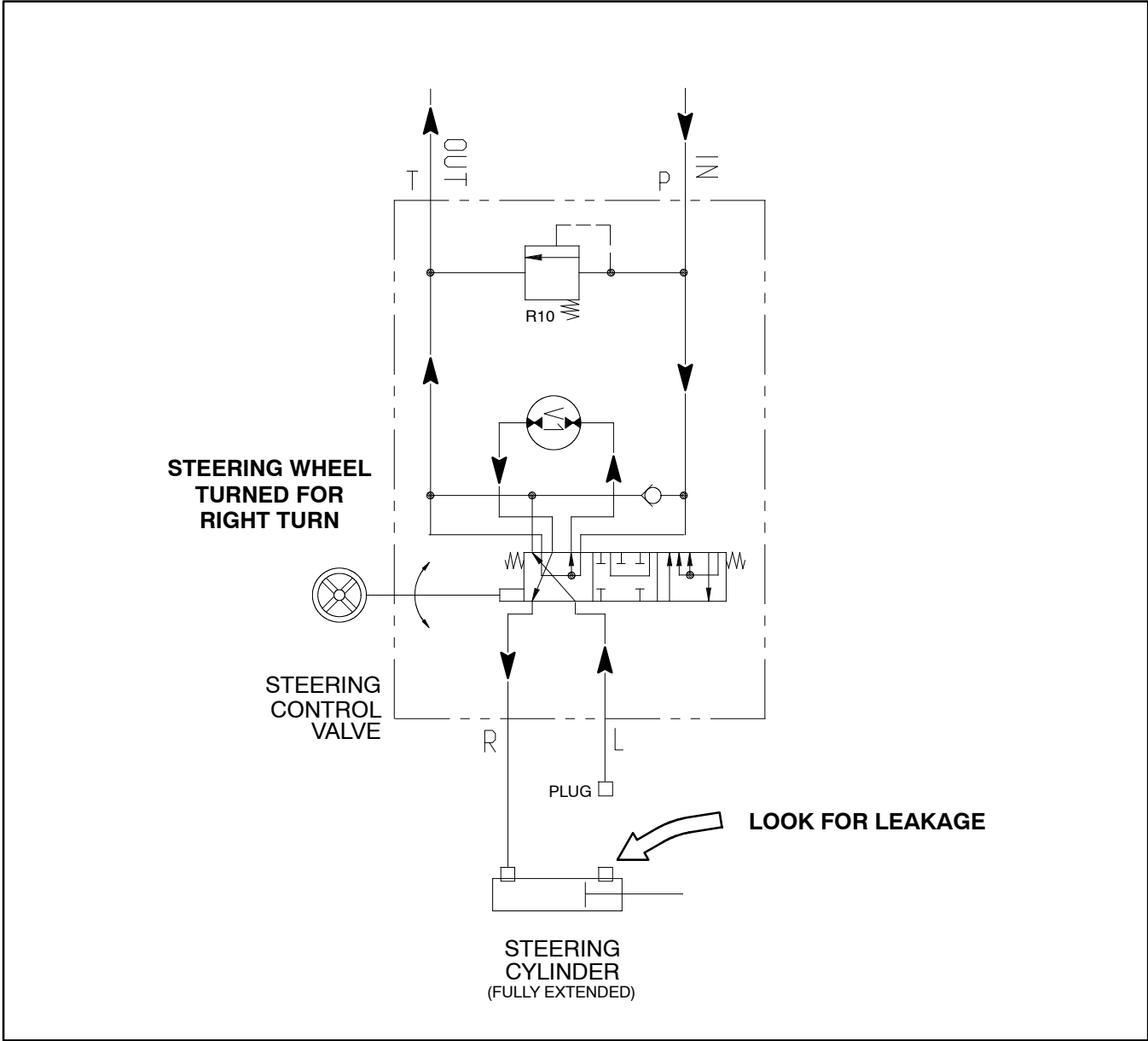



Figure 49

The steering cylinder internal leakage test should be performed if a steering problem is identified. This test will determine if the steering cylinder is faulty.

NOTE: Steering circuit operation will be affected by rear tire pressure, steering cylinder binding, extra weight on the vehicle and/or binding of rear axle steering components. Make sure that these items are checked before proceeding with steering cylinder internal leakage test.

Procedure for Steering Cylinder Internal Leakage Test:

1. Make sure hydraulic oil is at normal operating temperature by operating the machine under load for approximately ten (10) minutes.
2. Park machine on a level surface with the cutting units lowered and disengaged. Make sure engine is off. Apply the parking brake.
3. Read Precautions For Hydraulic Testing.

	CAUTION
Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.	

4. Turn the steering wheel for a right turn (clockwise) so the steering cylinder rod is fully extended.
5. Thoroughly clean the area around the hydraulic hose at the rod end of the steering cylinder (Fig. 50).
6. Place a drain pan under the steering cylinder. Remove hydraulic hose from the fitting on the rod end of the steering cylinder. Plug the end of the hose.

IMPORTANT: When capping hydraulic hose end, use a steel cap to ensure that fluid leakage will not occur. Plastic plugs will not hold hydraulic pressure that may be developed during this test procedure.

7. Install a steel plug in the open end of the disconnected hose to prevent leakage or contamination.

8. Remove all hydraulic oil from drain pan. Make sure that empty drain pan remains under the open fitting of the steering cylinder.

9. With the engine off, continue turning the steering wheel for a right turn (clockwise) with the steering cylinder fully extended. Observe the open fitting on the steering cylinder as the wheel is turned. If oil comes out of the fitting while turning the steering wheel to the right, the steering cylinder has internal leakage and must be repaired or replaced (see Steering Cylinder and Steering Cylinder Service in the Service and Repairs section of this chapter). Check drain pan for any evidence of oil that would indicate cylinder leakage.

10. When testing is completed, remove plug from the hydraulic hose. Reconnect hose to the steering cylinder fitting.

11. If a steering problem exists and the steering cylinder tested acceptably, the steering control valve requires service (see Steering Control Valve and Steering Control Valve Service in the Service and Repairs section of this chapter). Gear pump section (P2) could also be suspected of wear, damage or inefficiency (see Gear Pump (P2) Flow Test in this section).

NOTE: If the flow from the 2nd gear pump section (P2) is low, the traction charge circuit and steering circuit will both be affected.

12. Check oil level in hydraulic reservoir and adjust if needed.

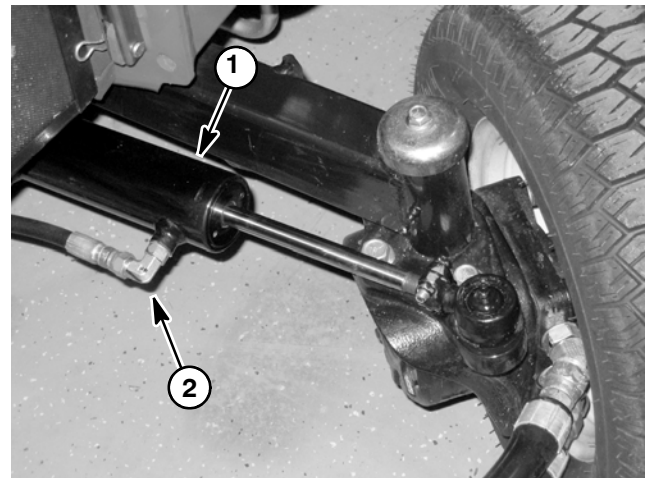


Figure 50

1. Steering cylinder
2. Rod end fitting

Service and Repairs

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, lower cutting units, engage parking brake and stop engine. Remove key from the ignition switch.
2. Thoroughly clean machine before disconnecting, removing or disassembling any hydraulic components. Make sure hydraulic components, hose connections and fittings are thoroughly cleaned. Always keep in mind the need for cleanliness when working on hydraulic components.



CAUTION

Before loosening any hydraulic component, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

3. Operate all hydraulic controls to relieve system pressure before loosening any hydraulic connection (see Relieving Hydraulic System Pressure in the General Information section of this chapter).
4. Put caps or plugs on any hydraulic lines, hydraulic fittings or components left open or exposed to prevent contamination.
5. Before disconnecting hydraulic lines or hoses, place labels to ensure proper installation after repairs are completed.
6. Note the position of hydraulic fittings (especially elbow fittings) on hydraulic components before removing the fittings. Mark parts if necessary to make sure that fittings will be aligned properly when reinstalling hydraulic hoses and tubes.

After Repair or Replacement of Components

1. If component failure is severe or hydraulic system is contaminated, flush hydraulic system (see Flush Hydraulic System in this section).
2. Lubricate O-rings and seals with clean hydraulic oil before installing hydraulic components.
3. Make sure all caps or plugs are removed from hydraulic tubes, hydraulic fittings and components before reconnecting.
4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Hose and Tube Installation and Hydraulic Fitting Installation in the General Information section of this chapter).
5. After repairs, check control linkages and cables for proper adjustment, binding or broken parts.
6. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Hydraulic System Start Up in this section).
7. Check for hydraulic oil leaks. If any leaks are discovered, shut off engine and correct leaks before continuing machine operation.
8. After performing any hydraulic repairs, check oil level in hydraulic reservoir and add correct oil if necessary.

Check Hydraulic Lines and Hoses



CAUTION

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings, weather deterioration and chemical deterioration. Make all necessary repairs before operating the machine.

Flush Hydraulic System

IMPORTANT: Flush the hydraulic system any time there is a severe component failure or the system is contaminated. Contaminated oil appears milky or black or contains metal particles.

1. Park machine on a level surface. Lower cutting units, stop engine, engage parking brake and remove key from ignition switch.

2. Drain hydraulic reservoir.

3. Clean area around the mounting area of the hydraulic filter. Remove and discard hydraulic filter.

4. Drain entire hydraulic system. Drain all hoses, tubes and components while the system is warm. Flush hoses and tubes to remove any contamination.

IMPORTANT: Follow all local codes and regulations when recycling or disposing hydraulic fluid and oil filter.

IMPORTANT: If a failure occurred in the traction circuit, traction circuit component disassembly and thorough cleaning may be required to remove contaminants from the traction circuit. Because the traction circuit is a closed loop, any contamination will remain in the circuit and can cause additional component damage unless it is removed.

5. Make sure the mounting surface of the hydraulic filter is clean. Apply clean hydraulic oil to gasket on new filter. Screw filter onto filter head until gasket contacts mounting plate, then tighten filter an additional 1/2 turn.

IMPORTANT: Use only hydraulic fluids specified in Traction Unit Operator's Manual. Other fluids could cause system damage.

6. Fill hydraulic reservoir with new hydraulic oil to proper level.

7. Disconnect wire harness connector from the fuel actuator to prevent the engine from starting.

8. Make sure traction pedal is in neutral and the PTO switch is OFF. Turn ignition key switch to start; engage starter for ten (10) seconds to prime hydraulic pumps. Wait sixty (60) seconds to allow the starter motor and starter solenoid to cool. Repeat this step again.

9. Connect wire harness connector to the fuel actuator to allow engine to start.

10. Start engine and let it idle at low speed for a minimum of two (2) minutes.

11. Increase engine speed to high idle for minimum of one (1) minute under no load.

12. Rotate steering wheel in both directions several times. Raise and lower cutting units several times.

13. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic reservoir and add correct oil if necessary.

14. Operate the machine for two (2) hours under normal operating conditions.

15. Check condition of hydraulic oil. If the fluid shows any signs of contamination, repeat steps 1 through 14 again.

16. Resume normal operation and follow recommended maintenance intervals.

Filtering Closed-Loop Traction Circuit

Filtering of a closed-loop hydraulic system after a major component failure (e.g. traction (piston) pump or wheel motor) is a requirement to prevent debris from transmitting throughout the system. If a closed-loop hydraulic system filtering tool is not used to ensure system cleanliness, repeat failures, as well as subsequent damage to other hydraulic components in the affected system, will occur. To effectively remove contamination from closed-loop traction circuit, use of the Toro high flow hydraulic filter and hydraulic hose kits are recommended (see Special Tools in this chapter).

1. Park machine on a level surface with engine stopped and key removed from ignition switch.
2. Raise and support machine so all wheels are off the ground (see Jacking Instructions in Chapter 1 - Safety).

NOTE: If wheel motor was replaced, install high flow filter to the inlet of the new motor instead of to the piston pump fitting. This will prevent system contamination from entering and damaging the new wheel motor.

3. Thoroughly clean junction of hydraulic hose and left side elbow fitting on bottom of piston (traction) pump (Fig. 51). Disconnect hose from left side pump fitting.
4. Connect Toro high flow hydraulic filter in series between piston (traction) pump fitting and disconnected hose. Use hydraulic hose kit (see Special Tools in this chapter) to connect filter to machine. Make sure that fitting and hose connections are properly tightened.

IMPORTANT: Use only hydraulic fluids specified in Operator's Manual. Other fluids could cause system damage.

5. After installing high flow filter to machine, check and fill hydraulic reservoir with new hydraulic oil as required.
6. Start engine and run at idle speed. Check for any hydraulic leakage from filter and hose connections. Correct any leaks before proceeding.


CAUTION

All wheels will be off the ground and rotating during this procedure. Make sure machine is well supported so it will not move and accidentally fall to prevent injuring anyone around machine.

IMPORTANT: While engaging the traction circuit, monitor the indicator on the high flow hydraulic filter. If the indicator should show red, either reduce pressure on the traction pedal or reduce engine speed to decrease hydraulic flow through the filter.

7. With engine running at low idle speed, slowly move the traction pedal to the forward direction to allow flow through the traction circuit and high flow filter. Keep traction circuit engaged for five (5) minutes while gradually increasing both forward pressure on traction pedal and engine speed. Monitor filter indicator to make sure that green color is showing during operation.
8. With engine running at high idle speed and traction pedal moved to the forward direction, periodically apply brakes to increase pressure in traction circuit. While monitoring filter indicator, continue this process for an additional five (5) minutes.

IMPORTANT: If using a filter that is not the Toro high flow filter that is bi-directional, do not press the traction pedal in the reverse direction. If flow is reversed when using a filter that is not bi-directional, debris from the filter will re-enter the traction circuit.

9. With engine running at high idle speed, alternately move traction pedal from forward to reverse. While monitoring filter indicator, continue this process for an additional five (5) minutes.
10. Shut engine off and remove key from ignition switch.
11. Remove high flow hydraulic filter and hydraulic hose kit from machine. Connect hydraulic hose to left side piston (traction) pump fitting. Make sure to properly tighten hose (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
12. Lower machine to ground.
13. Check oil level in hydraulic reservoir and add correct oil if necessary.

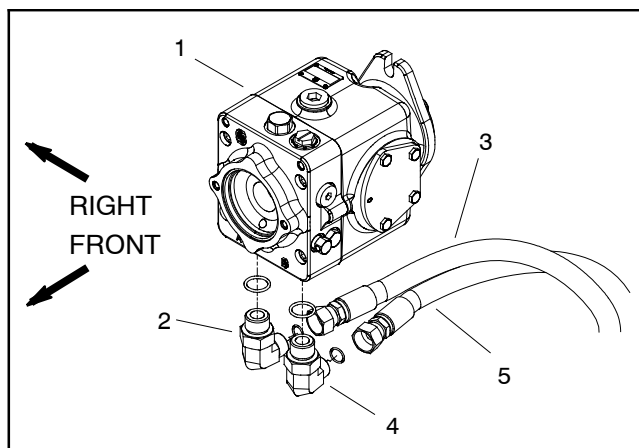


Figure 51

- | | |
|---------------------------|-----------------------|
| 1. Piston (traction) pump | 4. LH elbow fitting |
| 2. RH elbow fitting | 5. Hyd hose (reverse) |
| 3. Hyd hose (forward) | |

Hydraulic System Start- up

NOTE: When initially starting the hydraulic system with new or rebuilt components such as pumps, wheel motors or lift cylinders, it is important that this start- up procedure be used. This procedure reduces the chance of damaging the system or its components from not purging the system of air.

1. After the hydraulic system components have been properly installed and if the piston (traction) pump was rebuilt or replaced, make sure piston (traction) pump housing is at least half full of clean hydraulic oil.

2. Make sure all hydraulic connections and lines are secured tightly.

3. Drain, flush and refill hydraulic system and change hydraulic oil filter if component failure was severe or system is contaminated (see Flush Hydraulic System in this section).

4. Make sure hydraulic reservoir is full. Add correct oil if necessary.

5. Check control linkage for proper adjustment, binding or broken parts.

6. Disconnect electrical connector to the engine fuel actuator to prevent the engine from starting.

7. Make sure traction pedal is in neutral and the PTO switch is OFF. Turn ignition key switch to start; engage starter for ten (10) seconds to prime hydraulic pumps. Wait sixty (60) seconds to allow the starter motor and starter solenoid to cool. Repeat this step again.

8. Connect fuel actuator to allow engine to start.

9. Make sure traction pedal is in neutral and the PTO switch is OFF. Start engine and run it at low idle. The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in thirty (30) seconds, stop the engine and determine the cause.

10. If the piston (traction) pump was replaced or rebuilt, run the traction unit so the wheels turn slowly for ten (10) minutes.

11. Operate the traction unit (including steering and cutting unit lift/lower) by gradually increasing the work load to full over a ten (10) minute period.

12. Stop the machine. Check oil level in hydraulic reservoir and add correct oil if necessary. Check hydraulic components for leaks and tighten any loose connections.

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Hydraulic Reservoir

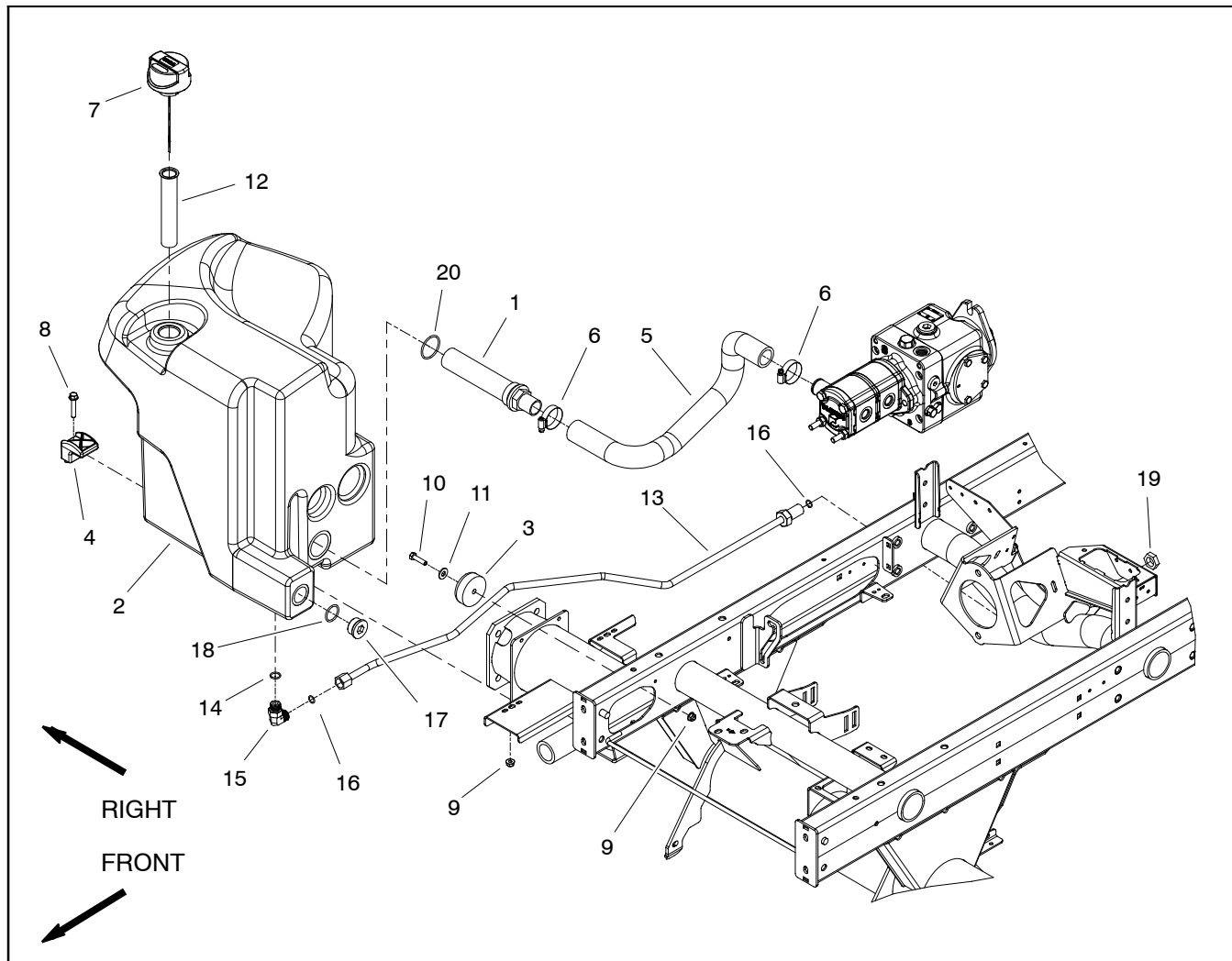


Figure 52

- | | | |
|------------------------|-------------------------------|---------------------------|
| 1. Suction strainer | 8. Washer head screw (2 used) | 15. 90o hydraulic fitting |
| 2. Hydraulic reservoir | 9. Flange nut (3 used) | 16. O-ring |
| 3. Recess bumper | 10. Cap screw | 17. SAE #16 plug |
| 4. Clamp (2 used) | 11. Flat washer | 18. O-ring |
| 5. Suction hose | 12. Filter screen | 19. Bulkhead nut |
| 6. Hose clamp (2 used) | 13. Hydraulic tube | 20. O-ring |
| 7. Reservoir cap | 14. O-ring | |

Removal (Fig. 52)

1. Thoroughly clean hydraulic hose ends and fittings on hydraulic reservoir to prevent hydraulic system contamination.
2. Drain hydraulic oil from reservoir.
3. Disconnect hydraulic lines from fittings on the reservoir. Allow hydraulic lines to drain into a suitable container. Plug or cap openings of reservoir and hydraulic lines to prevent leakage or contamination.
4. Remove hydraulic reservoir using Figure 52 as a guide.
5. Remove suction strainer (item 1) from reservoir. Discard O-ring.
6. If hydraulic fitting (item 15) is to be removed from reservoir, mark fitting orientation to allow correct assembly. Remove fitting from reservoir and discard O-ring.

Inspection (Fig. 52)

1. Clean hydraulic reservoir and suction strainer with solvent.
2. Inspect hydraulic reservoir for leaks, cracks or other damage.

Installation (Fig. 52)

1. If fitting (item 15) was removed from reservoir, lubricate and place new O-ring onto fitting. Install fitting into reservoir opening using marks made during the removal process to properly orientate fitting. Tighten fitting (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Lubricate new suction strainer O-ring and install onto strainer. Thread suction strainer into hydraulic reservoir until finger tight. Then, using a wrench, turn strainer into reservoir port 1 - 1/2 to 2 full turns beyond finger tight.
3. Position hydraulic reservoir to machine. Make sure that recess bumper (item 3) on right side of frame is inserted into recess in reservoir.
4. Secure reservoir to frame with two (2) clamps (item 4), washer head screws (item 8) and flange nuts (item 9).
5. Remove plugs and caps placed in hoses and fittings during the removal process.
6. Install and secure hydraulic lines to fittings on hydraulic reservoir (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
7. Fill hydraulic reservoir with **new** hydraulic fluid.
8. Operate machine. Check hydraulic lines and fittings for leaks. Tighten any loose connections. Check hydraulic oil level in reservoir and adjust if necessary.

Piston (Traction) Pump Control Assembly

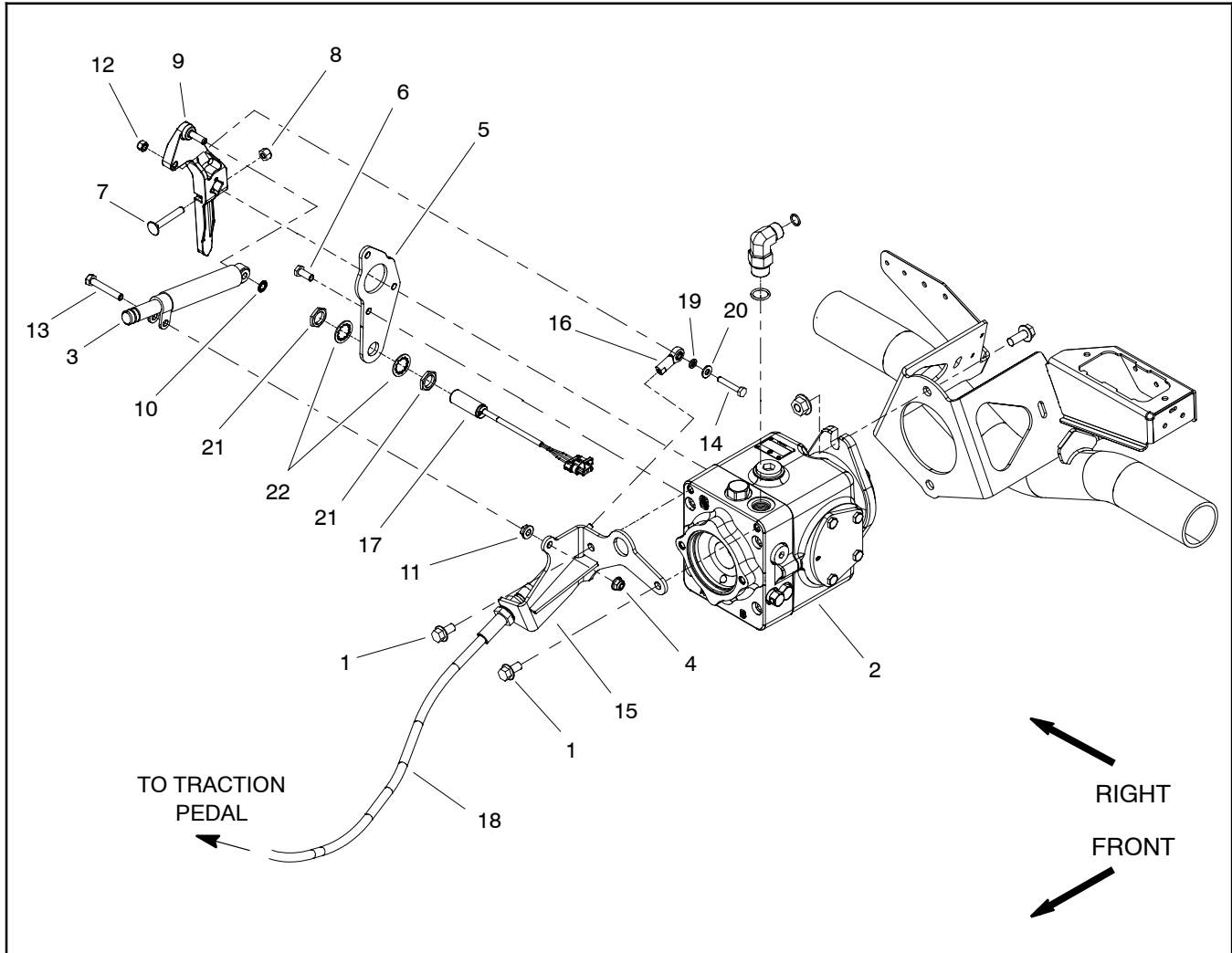


Figure 53

- | | | |
|-------------------------------|----------------------------|-----------------------------|
| 1. Flange head screw (2 used) | 9. Pump lever | 16. Cable rod end |
| 2. Piston (traction) pump | 10. Flat washer | 17. Traction neutral switch |
| 3. Lever damper | 11. Flange nut | 18. Traction control cable |
| 4. Flange nut | 12. Lock nut | 19. Flat washer |
| 5. Pump plate | 13. Cap screw | 20. Flat washer |
| 6. Cap screw (3 used) | 14. Cap screw | 21. Jam nut (2 used) |
| 7. Carriage screw | 15. Traction cable bracket | 22. Lock washer (2 used) |
| 8. Lock nut | | |

Disassembly (Fig. 53)

1. Park the machine on a level surface, engage parking brake, lower cutting units and stop engine. Remove key from the ignition switch.

2. Remove components from piston (traction) pump control assembly as needed using Figures 53 and 54 as guides.

Assembly (Fig. 53)

IMPORTANT: To prevent traction neutral switch (item 17) damage, make sure that no pump control components contact switch through entire piston (traction) pump control arm movement.

1. Install removed components to piston (traction) pump control assembly using Figures 53 and 54 as guides along with the following:

A. If traction neutral switch (item 17) was removed from pump plate, adjust location of switch so that there is from **0.094" to 0.100" (2.4 to 2.5 mm)** clearance between the head of neutral switch and the piston (traction) pump lever (Refer to Traction Neutral Switch in the Adjustments section of Chapter 5 - Electrical System for additional neutral switch information).

2. After piston (traction) pump control assembly has been installed, make sure that the piston pump is adjusted for the neutral position so that the machine does not move or creep when the traction pedal is in neutral (see Traction Unit Operator's Manual).

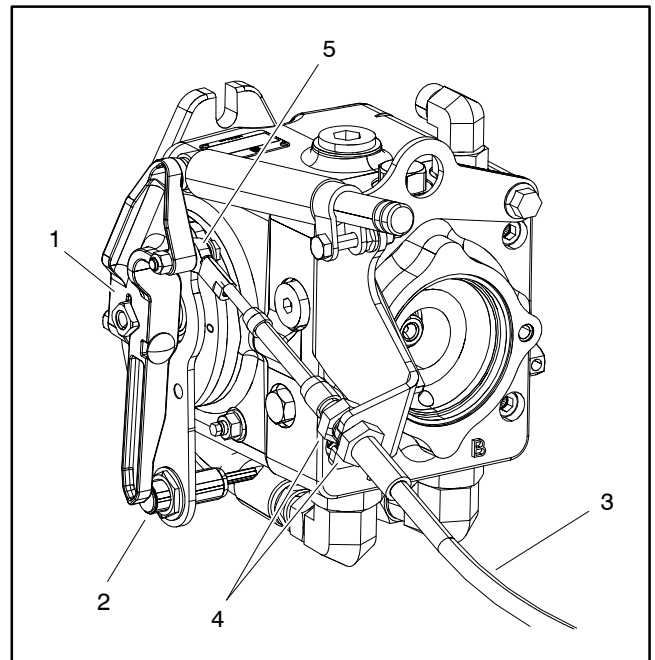


Figure 54

- | | |
|----------------------------|------------------|
| 1. Pump lever | 4. Cable jam nut |
| 2. Traction neutral switch | 5. Cable rod end |
| 3. Traction control cable | |

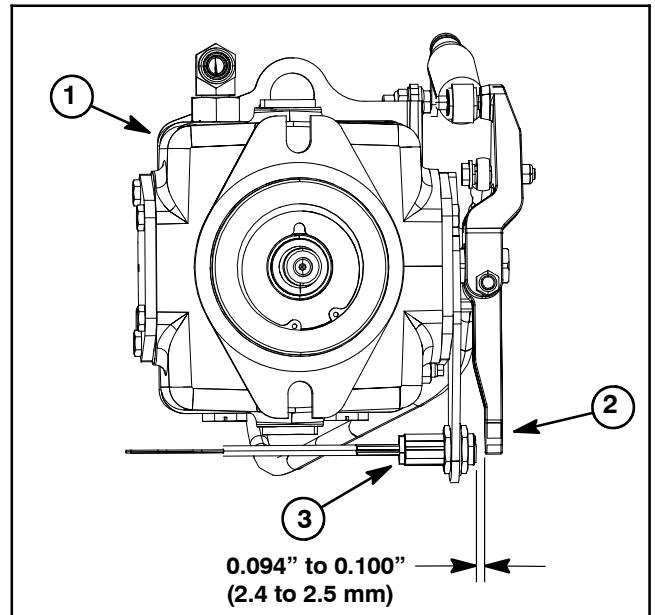


Figure 55

- | | |
|----------------|----------------------------|
| 1. Piston pump | 3. Traction neutral switch |
| 2. Pump lever | |

Hydraulic Pump Assembly

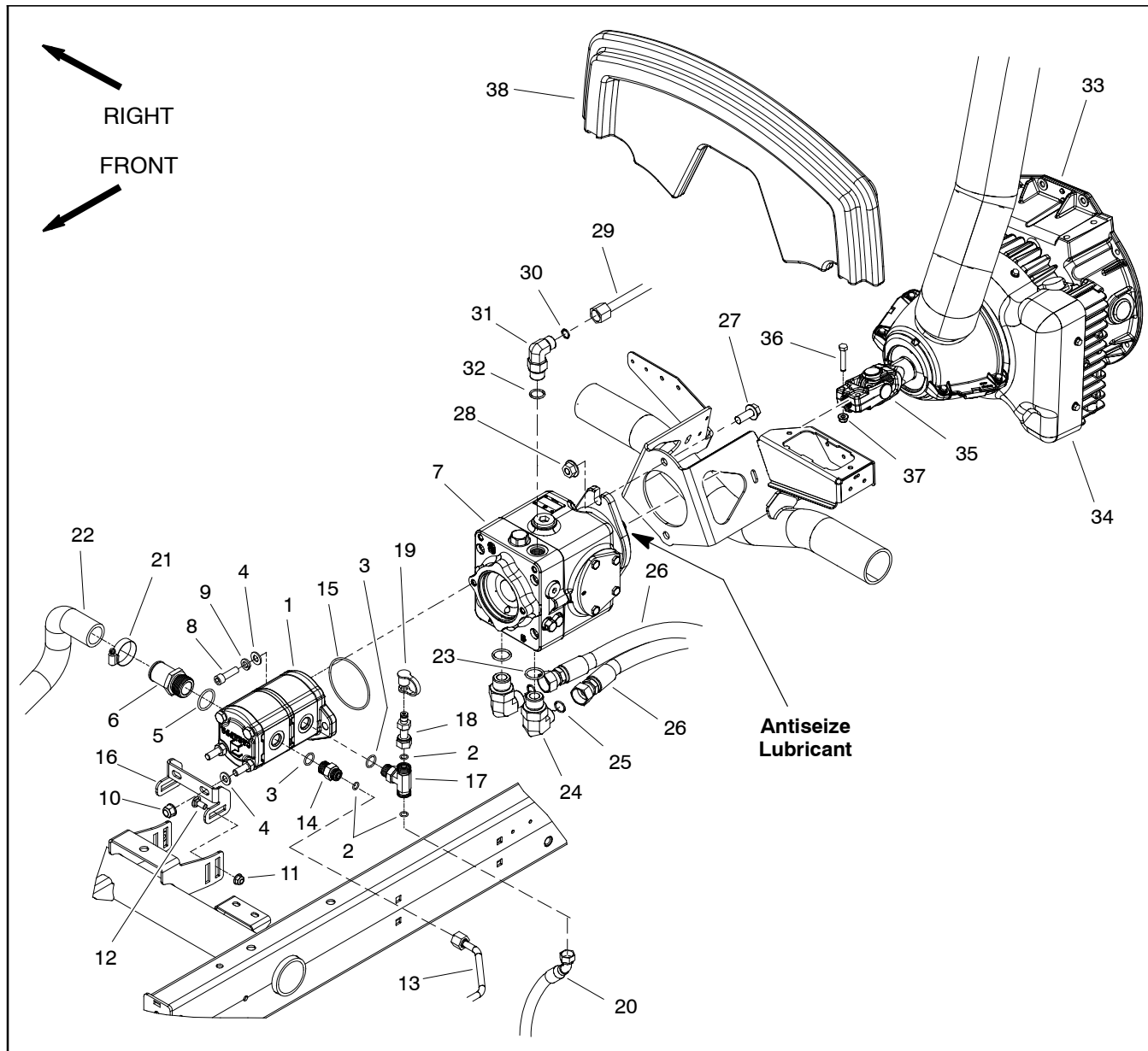



Figure 56

- | | | |
|------------------------------------|------------------------------------|--------------------------------|
| 1. Gear pump assembly | 14. Hydraulic fitting | 27. Flange head screw (2 used) |
| 2. O-ring | 15. O-ring | 28. Flange nut (2 used) |
| 3. O-ring | 16. Pump support bracket | 29. Hydraulic tube |
| 4. Flat washer (4 used) | 17. Hydraulic tee fitting | 30. O-ring |
| 5. O-ring | 18. Hydraulic test fitting | 31. 90° hydraulic fitting |
| 6. Hydraulic fitting | 19. Dust cap | 32. O-ring |
| 7. Piston (traction) pump assembly | 20. Hydraulic hose | 33. Engine bellhousing |
| 8. Socket head screw (2 used) | 21. Hose clamp | 34. 48 VDC motor/generator |
| 9. Lock washer (2 used) | 22. Hydraulic (suction) hose | 35. Pump drive shaft |
| 10. Lock nut (2 used) | 23. O-ring | 36. Cap screw (2 used) |
| 11. Flange nut (2 used) | 24. 90° hydraulic fitting (2 used) | 37. Flange nut (2 used) |
| 12. Carriage screw (2 used) | 25. O-ring | 38. Hood saddle |
| 13. Hydraulic tube | 26. Hydraulic hose (2 used) | |

NOTE: Piston (traction) pump and gear pump should be removed from machine as an assembly. Once removed from machine, pumps can be separated for necessary service.

Removal (Fig. 56)

1. Park the machine on a level surface, engage parking brake, lower cutting units and stop engine. Remove key from the ignition switch.
2. Raise and support hood and operator seat. Lift hood saddle from frame brackets and remove from machine.
3. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

**CAUTION**

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

4. To prevent contamination of the hydraulic system, thoroughly clean piston (traction) and gear pump assembly and all hydraulic connections.
5. Label hydraulic hoses to assist in assembly. Disconnect all hydraulic hoses and tubes from fittings on the piston (traction) and gear pump assembly. Allow hydraulic lines to drain into a suitable container. Plug or cap openings of pumps and lines to prevent contamination.
6. Remove two (2) cap screws (item 36) and flange nuts (item 37) that secure pump drive shaft to piston (traction) pump input shaft.
7. Disconnect traction control cable from piston (traction) pump (see Piston (Traction) Pump Control Assembly in this section). Carefully position traction control cable away from piston pump.

8. Disconnect wire harness electrical connector from traction neutral switch on piston pump control assembly and position harness away from pump assembly.

IMPORTANT: Dry weight of pump assembly is approximately 68 pounds (31 kg).

9. Connect a lift or hoist to hole in traction cable bracket on piston pump to support pump assembly and for pump removal.

10. Loosen and remove two (2) carriage screws (item 12) and flange nuts (item 11) that secure pump support bracket to frame.

11. Remove two (2) flange screws (item 27) and flange nuts (item 28) that secure piston (traction) pump flange to machine frame.

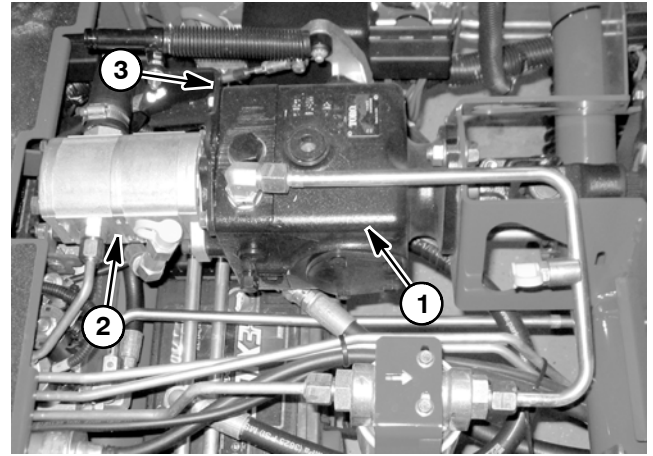


Figure 57

1. Piston (traction) pump
2. Gear pump
3. Traction cable bracket

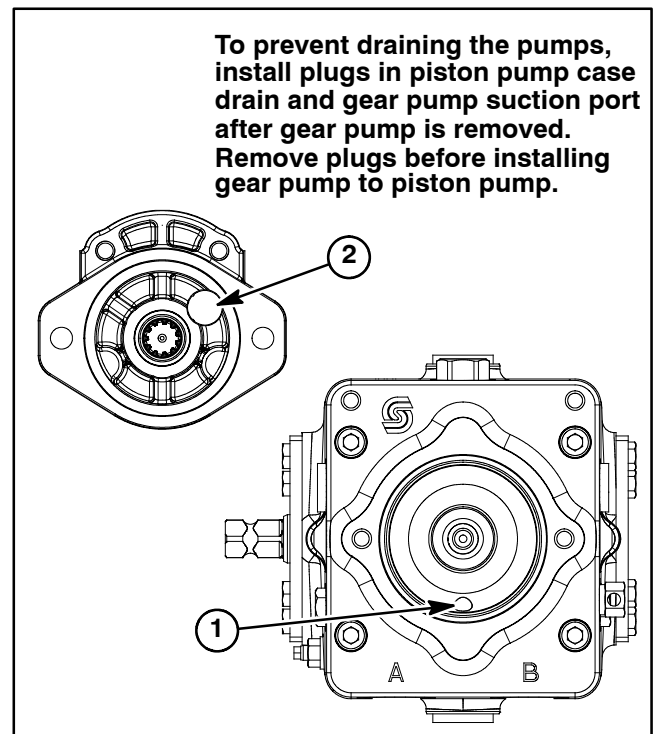


Figure 58

1. Piston pump case drain
2. Gear pump suction port

IMPORTANT: Make sure to not damage machine components while removing the pump assembly.

12. Carefully lift pump assembly from the machine. Place assembly on suitable workbench.

NOTE: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Fig. 58). When the gear pump is removed from the piston pump, plug piston pump case drain hole to prevent draining the piston pump.

13. Remove two (2) socket head screws, lock washers and flat washers that secure gear pump to piston (traction) pump. Remove gear pump from piston (traction) pump. Locate and discard O-ring (item 15) from between pumps.

14. If necessary, remove hydraulic fittings from pumps. Note orientation of fittings for assembly purposes.

15. Remove and discard all O-rings from removed hydraulic lines and fittings.

16. If necessary, remove two (2) lock nuts (item 10) that secure pump support bracket (item 16) to gear pump. Remove bracket and two (2) flat washers (item 4) from gear pump.

Installation (Fig. 56)

1. If fittings were removed from pump assembly, lightly lubricate new fitting O-rings with clean hydraulic oil. Install fittings with O-rings to the pump assembly (see Hydraulic Fitting Installation in the General Information section of this chapter). Orientate fittings as noted during removal.

2. If pump support bracket (item 16) was removed from gear pump, fit flat washers and bracket to gear pump and secure with two (2) lock nuts.

IMPORTANT: A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Fig. 58). Before the gear pump is installed to the piston pump, make sure that plugs placed in either of these ports are removed. Failure to remove plugs will cause excessive pressure in the piston pump and damage seals. Also, before securing gear pump to piston pump, fill piston pump housing with clean hydraulic oil through case drain hole.

3. Remove plugs that were placed in piston pump case drain and gear pump suction port. Fill piston pump housing with new hydraulic oil through case drain hole.

4. Lubricate and position new O-ring (item 15) between pumps. Position gear pump to piston (traction) pump and secure with two (2) socket head screws, lock washers and flat washers.

IMPORTANT: Make sure to not damage machine components while installing the pump assembly.

5. Carefully lower pump assembly to machine frame. Align piston pump input shaft to pump drive shaft and slide pump assembly to machine frame.

6. Secure pump assembly to machine frame with two (2) flange screws and flange nuts.

7. Secure pump support bracket to inside of frame bracket with two (2) carriage screws (item 12) and flange nuts (item 11).

8. Install hydraulic hoses to fittings on pump assembly in positions noted during removal (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

9. Connect machine wire harness electrical connector to traction neutral switch on piston pump control assembly.

10. Position traction control cable to piston (traction) pump. Secure cable to pump lever and cable bracket (see Piston (Traction) Pump Control Assembly in this section).

11. Secure pump drive shaft to piston (traction) pump input shaft with two (2) cap screws (item 36) and flange nuts (item 37).

12. Install hood saddle onto frame brackets. Lower and secure hood and operator seat.

13. Check oil level in hydraulic reservoir and add correct oil if necessary.

14. Follow hydraulic system start-up procedures (see Hydraulic System Start-up in this section).

15. Check traction drive for neutral and traction neutral switch operation. Adjust if necessary.

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Piston (Traction) Pump Service

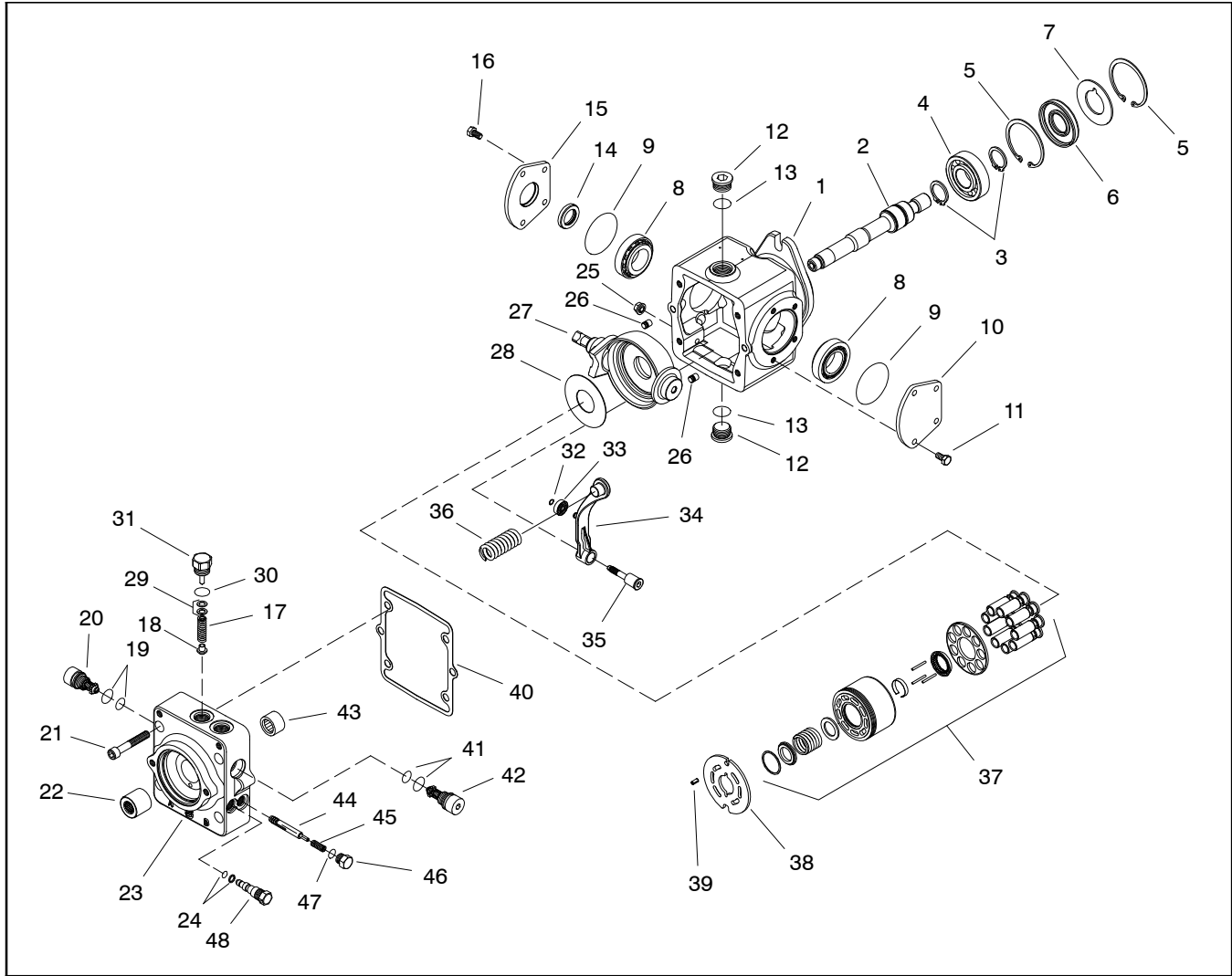


Figure 59

- | | | |
|-----------------------------------|----------------------------|----------------------------|
| 1. Piston (traction) pump housing | 17. Spring | 33. Bearing |
| 2. Auxiliary shaft | 18. Charge relief poppet | 34. Neutral return arm |
| 3. Retaining ring | 19. Seal kit | 35. Neutral return pivot |
| 4. Ball bearing | 20. Relief valve (forward) | 36. Spring |
| 5. Retaining ring | 21. Screw (4 used) | 37. Cylinder block kit |
| 6. Seal | 22. Coupling | 38. Valve plate |
| 7. Backup washer | 23. End cap | 39. Slotted pin |
| 8. Bearing (2 used) | 24. Seal kit | 40. End cap gasket |
| 9. O-ring | 25. Seal nut | 41. Seal kit |
| 10. Trunnion cover | 26. Pin | 42. Relief valve (reverse) |
| 11. Screw (4 used) | 27. Swashplate | 43. Needle bearing |
| 12. Plug (2 used) | 28. Thrust plate | 44. Loop flushing spool |
| 13. O-ring | 29. Shim kit | 45. Spring |
| 14. Seal | 30. O-ring | 46. Plug |
| 15. Trunnion cover | 31. Charge relief plug | 47. O-ring |
| 16. Screw (4 used) | 32. Retaining ring | 48. Bypass valve |

NOTE: For piston (traction) pump repair information, see the Sauer- Danfoss LPV Closed Circuit Axial Piston Pumps Repair Manual and Service Instructions at the end of this chapter.

IMPORTANT: If a piston (traction) pump failure occurred, refer to **Traction Circuit Component Failure in the General Information section** for information regarding the importance of removing contamination from the traction circuit.

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Gear Pump Service

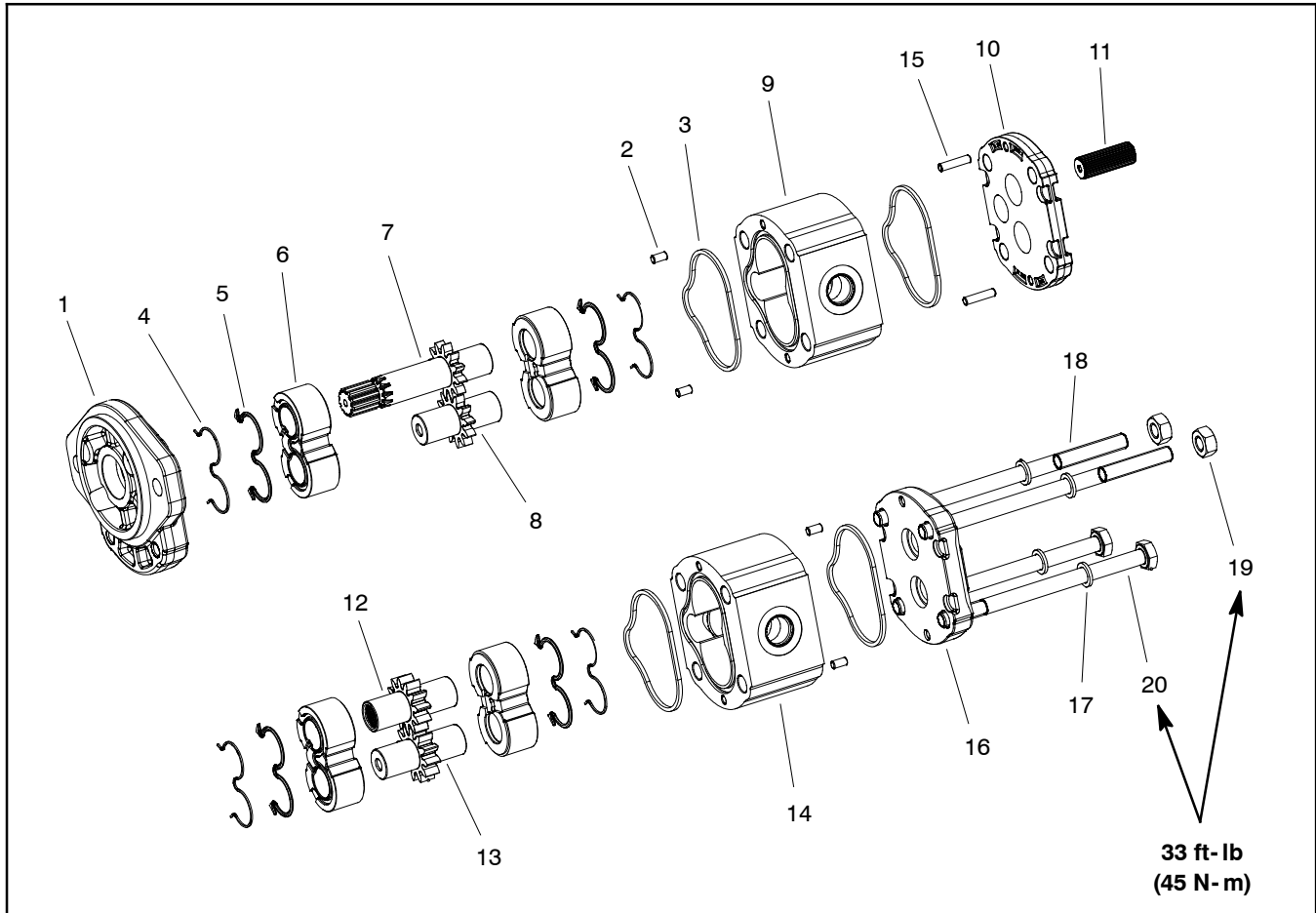


Figure 60

- | | | |
|---------------------------------|------------------------------|------------------------|
| 1. Front cover | 8. Driven gear | 15. Dowel pin (2 used) |
| 2. Dowel pin (4 used) | 9. Body | 16. Rear cover |
| 3. Square section seal (4 used) | 10. Flange | 17. Washer (4 used) |
| 4. Back-up seal (4 used) | 11. Splined connecting shaft | 18. Stud bolt (2 used) |
| 5. Pressure seal (4 used) | 12. Drive gear | 19. Nut (2 used) |
| 6. Thrust plate (4 used) | 13. Driven gear | 20. Cap screw (2 used) |
| 7. Drive shaft | 14. Body | |

Disassembly (Fig. 60)

NOTE: The gear pump must be replaced as a complete assembly. Individual gears, housings and thrust plates are not available separately. Disassemble gear pump for cleaning, inspection and seal replacement only.

IMPORTANT: Keep bodies, gears and thrust plates for each pump section together; do not mix parts between pump sections.

1. Plug pump ports and thoroughly clean exterior of pump with cleaning solvent. Make sure work area is clean.

2. Use a marker to make a **diagonal** line across the gear pump for assembly purposes (Fig. 61).

IMPORTANT: Use caution when clamping gear pump in a vise to avoid distorting any pump components.

3. Secure the front cover of the pump in a vise with the drive shaft pointing down.

4. Loosen the two (2) cap screws and two (2) nuts that secure pump assembly.

5. Remove pump from vise and remove loosened fasteners.

6. Support the pump assembly and gently tap the pump case with a soft face hammer to loosen the pump sections. Be careful to not drop parts or disengage gear mesh.

IMPORTANT: Mark the relative positions of the gear teeth and the thrust plates so they can be reassembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

7. Remove the thrust plates and seals from each pump section. Before removing each gear set, apply marking dye to mating teeth to retain "timing". Pump efficiency may be affected if the teeth are not installed in the same position during assembly. Keep the parts for each pump section together; do not mix parts between sections.

8. Clean all gear pump parts. Check all components for burrs, scoring, nicks and other damage.

9. Replace the entire pump assembly if component parts are excessively worn or scored.

Assembly (Fig. 60)

1. Apply clean hydraulic oil to all parts before assembling.

NOTE: Pressure and back-up seals fit in grooves machined into thrust plates. Square section seals fit in grooves machined in body faces.

2. Assemble pump sections starting at front cover end. Apply grease or petroleum jelly to new section seals to hold them in position during gear pump assembly.

3. After pump has been assembled, tighten cap screws and nuts by hand.

4. Place a small amount of clean hydraulic fluid into the inlet of the gear pump and rotate the drive shaft away from the inlet one revolution. Protect the shaft if using pliers for turning the shaft. If any binding is noted, disassemble the pump and check for assembly problems.

5. Tighten the cap screws and nuts evenly in a crossing pattern to a torque of **33 ft-lb (45 N-m)**.

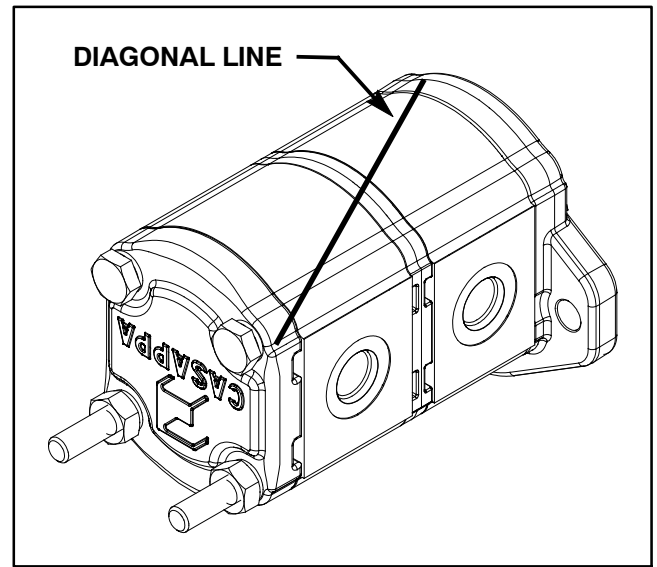


Figure 61

Hydraulic Pump Drive Shaft

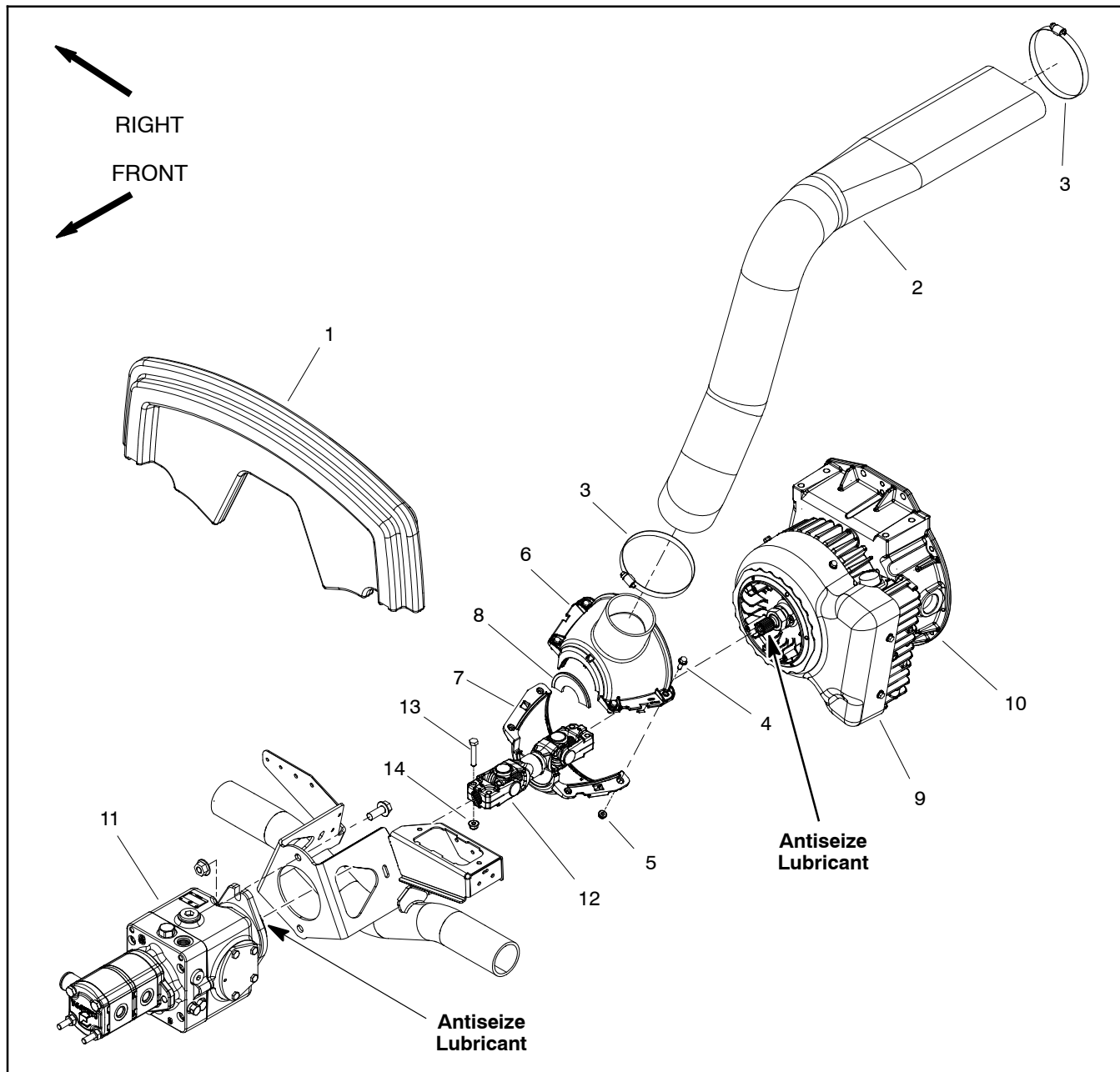


Figure 62

- | | | |
|-------------------------------|------------------------------------|-----------------------------|
| 1. Hood saddle | 6. Upper intake shroud | 11. Hydraulic pump assembly |
| 2. Air intake hose | 7. Lower intake shroud | 12. Drive shaft assembly |
| 3. Hose clamp (2 used) | 8. Brush seal (2 used) | 13. Cap screw (4 used) |
| 4. Flange head screw (4 used) | 9. 48 VDC motor/generator assembly | 14. Flange nut (4 used) |
| 5. Flange nut (4 used) | 10. Engine bellhousing | |

Removal (Fig. 62)

1. Park the machine on a level surface, engage parking brake, lower cutting units and stop engine. Remove key from the ignition switch.
2. Raise and support hood and operator seat. Lift hood saddle (item 1) from frame brackets and remove from machine.
3. Loosen hose clamp that secures air intake hose (item 2) to upper intake shroud. Carefully slide intake hose from upper shroud.
4. Remove intake shrouds (items 6 and 7) and brush seals (item 8) from machine.
 - A. Remove four (4) flange head screws (item 4) and flange nuts (item 5) that secure upper and lower intake shrouds.
 - B. Separate tabs on upper shroud from slots on lower shroud. Remove shrouds and brush seals from machine.
 - C. Note location of four (4) compression limiter spacers in the upper shroud mounting holes.
5. Remove cap screws (item 13) and flange nuts (item 14) that secure drive shaft yokes to hydraulic pump input shaft and motor/generator output shaft.

6. Slide drive shaft yokes from hydraulic pump and motor/generator shafts and remove drive shaft assembly from machine.

Installation (Fig. 62)

1. Apply antiseize lubricant to hydraulic pump input shaft and motor/generator output shaft.
2. Position drive shaft assembly to hydraulic pump and motor/generator shafts. The drive shaft male yoke should be installed onto motor/generator shaft (Fig. 63). Position female yoke fully onto pump shaft so the shaft end is flush with the inside of the yoke flange.

3. Secure drive shaft yokes to pump and motor/generator shafts with two (2) cap screws (item 5) and flange nuts (item 9).
4. Lubricate drive shaft grease fittings.
5. Secure intake shrouds (items 6 and 7) and brush seals (item 8) to machine.
 - A. Make sure that four (4) compression limiter spacers are placed in the mounting holes in the upper intake shroud.
 - B. Position intake shrouds and brush seals around drive shaft. Make sure that brush seals fit in grooves of shrouds and grooves in shrouds fit onto flange on motor/generator cover. Insert upper shroud tabs into lower shroud openings.
 - C. Secure upper and lower intake shrouds with four (4) flange head screws (item 4) and flange nuts (item 5).
6. Carefully slide intake hose (item 2) onto upper shroud and secure in place with hose clamp.
7. Install hood saddle (item 1) onto frame brackets. Lower and secure hood and operator seat.

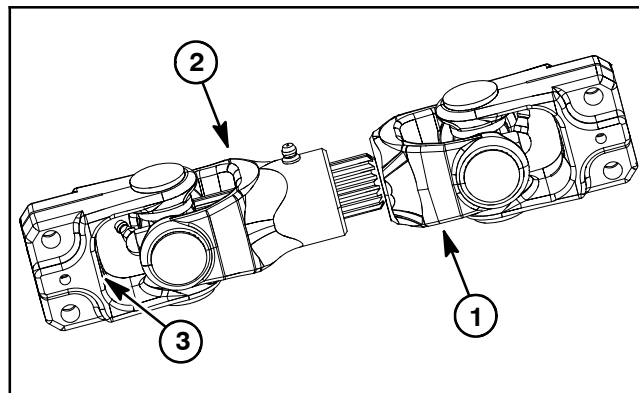


Figure 63

1. Male yoke (generator)
2. Female yoke (pump)
3. Inside of flange

Hydraulic Pump Drive Shaft Cross and Bearing Service

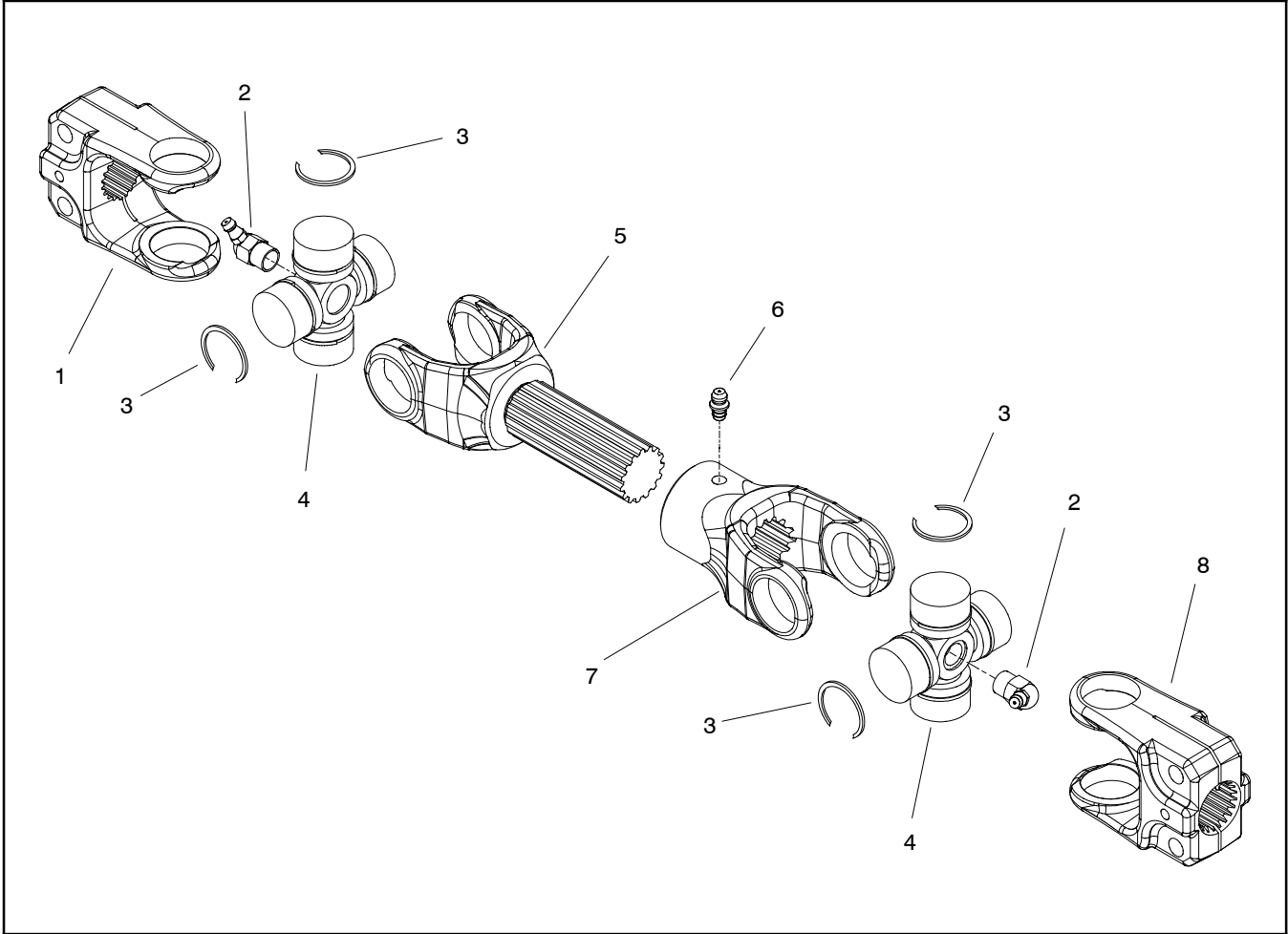


Figure 64

- 1. End yoke (motor/generator)
- 2. Grease fitting (2 used)
- 3. Snap ring (4 per cross and bearing)
- 4. Cross and bearing assembly
- 5. Shaft yoke (male)
- 6. Grease fitting
- 7. Telescoping yoke (female)
- 8. End yoke (piston pump)

Disassembly (Fig. 64)

1. Remove hydraulic pump drive shaft from vehicle (see Hydraulic Pump Drive Shaft in this section).

IMPORTANT: When placing yoke in vise, clamp lightly on the solid part of the yoke to prevent yoke damage. Also, the use of a vise with soft jaws is recommended.

2. Lightly clamp drive shaft yoke in vise. Use two screwdrivers to remove snap rings that secure bearings at the inside of each yoke. Remove yoke from vise.

IMPORTANT: Yokes must be supported when removing and installing bearings to prevent damage.

3. Use a press to remove cross and bearings from yokes:
 - A. Place a small socket against one bearing and a large socket against the yoke on the opposite side.
 - B. While supporting the large socket, apply pressure on small socket to partially push the opposite bearing into the large socket.
 - C. Remove yoke from press, grasp partially removed bearing and tap on yoke to completely remove the bearing.
 - D. Repeat process for remaining bearings.
4. Thoroughly clean and inspect all components.

Assembly (Fig. 64)

1. To install new cross and bearings:

- A. Apply a coating of grease to bearing bores of end yoke and shaft yoke. Also, apply grease to bearings and seal of bearing assembly. Make sure that all bearing rollers are properly seated in bearing cage.

- B. Press one bearing partially into yoke.

IMPORTANT: Take care when installing cross into bearing to avoid damaging bearing seal.

- C. Carefully insert cross into bearing and yoke.

- D. Hold cross in alignment and press bearing in until it hits the yoke.

- E. Carefully place second bearing into yoke bore and onto cross shaft. Press bearing into yoke.

- F. Install snap rings to bearings to secure bearings in place.

- G. Repeat procedure for other yoke.

- H. Grease cross until grease comes out of all four (4) bearing cups.

2. Make sure that assembled joint moves without binding. Slight binding can usually be eliminated by lightly rapping the yoke lugs with a soft faced hammer. If binding continues, disassemble joint to identify source of binding.

3. Install hydraulic pump drive shaft to vehicle (see Hydraulic Pump Drive Shaft in this section).

Front Wheel Motors

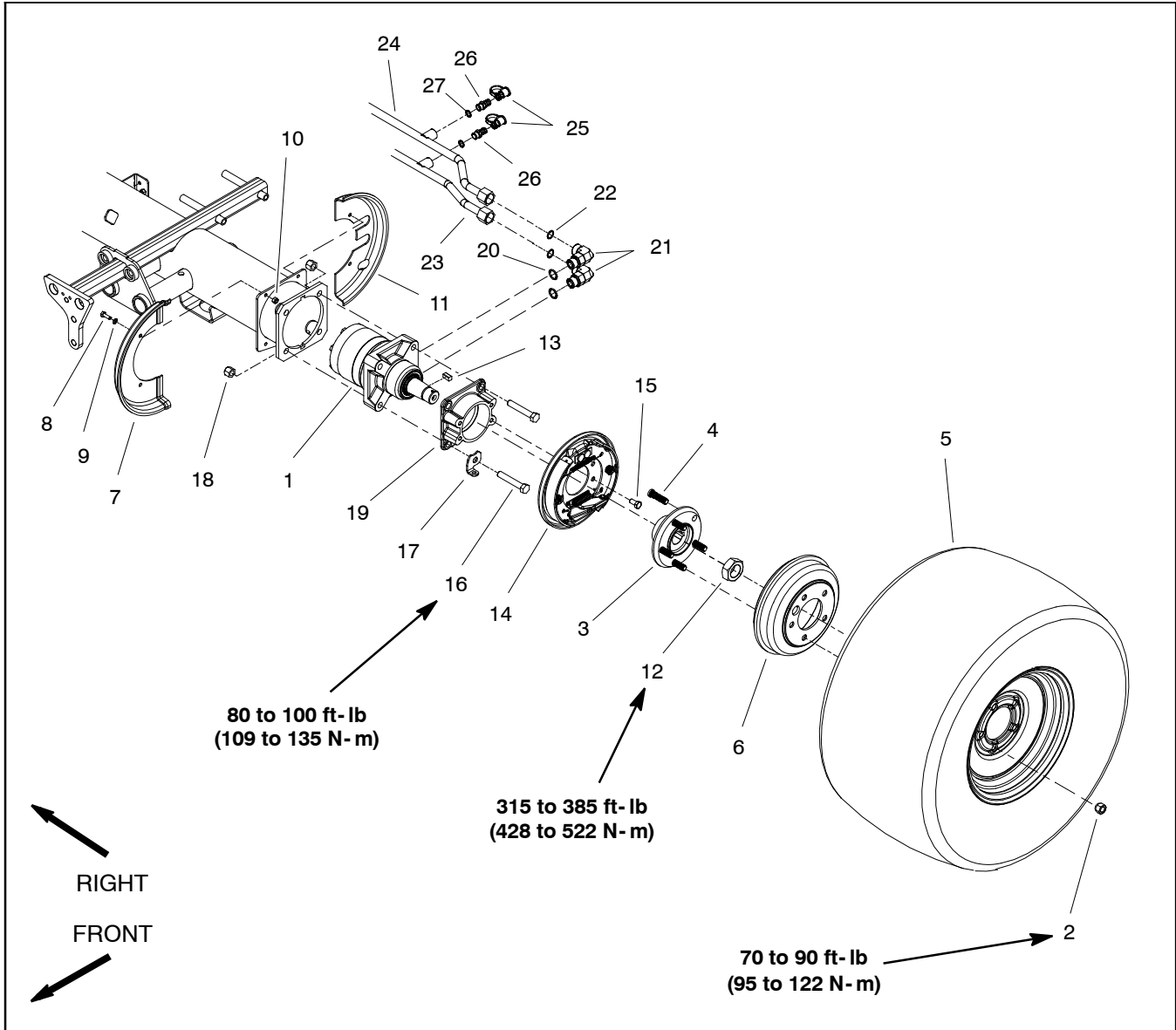
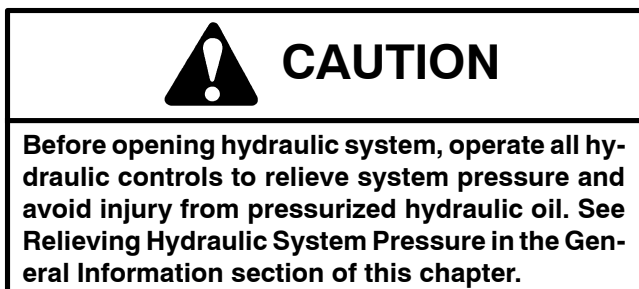


Figure 65

- | | | |
|------------------------------------|---------------------------------------|---------------------------|
| 1. Wheel motor (LH shown) | 10. Lock nut (2 used per shield) | 19. Brake adapter |
| 2. Lug nut (5 used per wheel) | 11. Rear wheel shield (LH shown) | 20. O-ring |
| 3. Hub | 12. Lock nut | 21. 90° hydraulic fitting |
| 4. Wheel stud (5 used per wheel) | 13. Square key | 22. O-ring |
| 5. Wheel assembly | 14. Brake assembly (LH shown) | 23. Hydraulic tube |
| 6. Brake drum | 15. Cap screw (4 used per brake assy) | 24. Hydraulic tube |
| 7. Front wheel shield (2 used) | 16. Cap screw (4 used per motor) | 25. Dust cap |
| 8. Cap screw (2 used per shield) | 17. Spring clip (LH shown) | 26. Test fitting |
| 9. Flat washer (2 used per shield) | 18. Lock nut (4 used per motor) | 27. O-ring |

Removal (Fig. 65)

1. Park the machine on a level surface, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Chock rear wheels to prevent machine from moving or shifting.
3. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
4. Remove front wheel, brake drum, wheel hub and brake assembly from machine (see Brake Service in the Service and Repairs section of Chapter 6 - Chassis).



5. Thoroughly clean hydraulic tube ends and fittings on wheel motor to prevent hydraulic system contamination.
6. Label hydraulic connections at wheel motor for assembly purposes.
7. Disconnect hydraulic tubes from fittings on wheel motor. Allow tubes to drain into a suitable container.
8. Put caps or plugs on disconnected tubes and fittings to prevent contamination.

NOTE: Right and left front wheel motors are the same basic design with some minor differences. The left side wheel motor can be identified by the machined groove on the end of the output shaft. If both motors are removed from the machine, label motors for assembly purposes.

9. Support wheel motor to prevent it from falling. Remove four (4) lock nuts from cap screws that secure motor and brake adapter to frame.
10. Note location of spring clip (item 17) for assembly purposes. Remove four (4) cap screws and brake adapter from wheel motor and frame.
11. Remove wheel motor from machine.
12. If hydraulic fittings are to be removed from wheel motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

Installation (Fig. 65)

1. If fittings were removed from wheel motor, lubricate and place new O-rings to fittings. Install fittings into motor ports using marks made during the removal process to properly orientate fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
 2. Position wheel motor and brake adapter to frame. Install spring clip (item 17) and four (4) cap screws to wheel motor and frame. Make sure that spring clip is positioned as noted during disassembly.
 3. Install and tighten four (4) lock nuts onto cap screws to secure motor and brake bracket to frame. Torque lock nuts from **80 to 100 ft-lb (109 to 135 N-m)**.
 4. Remove caps and plugs from disconnected hydraulic tubes and fittings.
 5. Lubricate and position new O-rings to fittings on wheel motor. Use labels placed during the removal process to properly install and secure hydraulic tubes to wheel motor fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
 6. Install brake assembly, wheel hub, brake drum and front wheel to machine (see Brake Service in the Service and Repairs section of Chapter 6 - Chassis).
 7. Make sure that wheel hub lock nut (item 12) is tightened from **315 to 385 ft-lb (428 to 522 N-m)** and wheel lug nuts are tightened from **70 to 90 ft-lb (95 to 122 N-m)**.
 8. Check and adjust oil level in hydraulic reservoir.
- IMPORTANT:** If a wheel motor failure occurred, refer to **Traction Circuit Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.**
9. Operate machine functions slowly until air is out of system (see Charge Hydraulic System in this section).

Front Wheel Motor Service

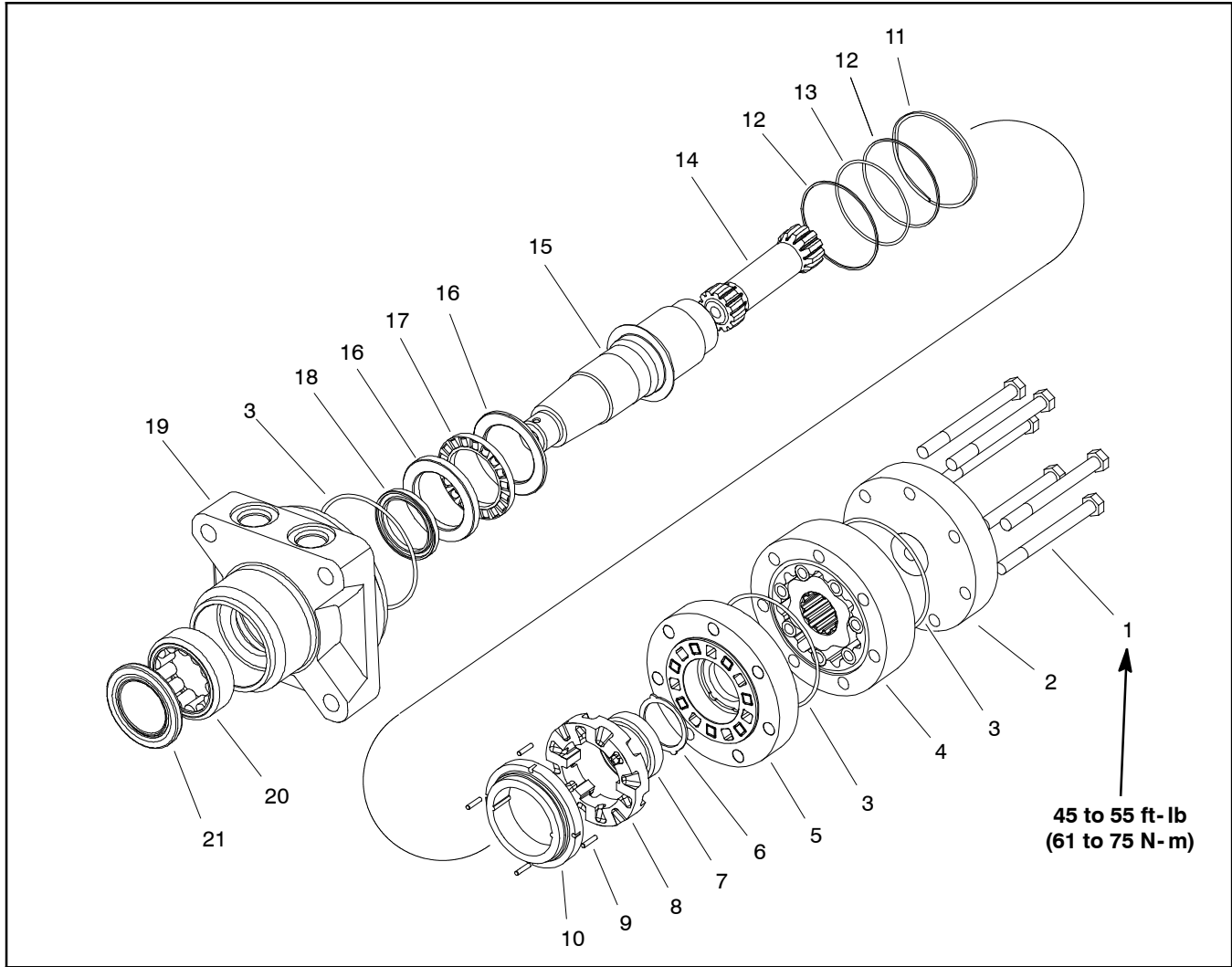


Figure 66

- 1. Cap screw (7 used)
- 2. End cap
- 3. O-ring (3 used)
- 4. Geroler assembly
- 5. Valve plate
- 6. Thrust bearing
- 7. Bearing

- 8. Valve
- 9. Dowel pin (4 used)
- 10. Balancing ring
- 11. Valve spring
- 12. Back-up ring
- 13. O-ring
- 14. Drive

- 15. Output shaft
- 16. Bearing race (2 used)
- 17. Thrust bearing
- 18. Shaft seal
- 19. Housing
- 20. Bearing
- 21. Grease seal

NOTE: The front wheel motors are Eaton Delta motors of the same basic design with minor differences. The right side motor has a reverse timed manifold to allow correct rotation direction for forward and reverse. The left side wheel motor can be identified by the machined groove on the end of the output shaft.

NOTE: For front wheel motor repair procedures, see the Eaton Delta Motors Parts and Repair Manual at the end of this chapter.

IMPORTANT: If a wheel motor failure occurred, refer to **Traction Circuit Component Failure in the General Information section** for information regarding the importance of removing contamination from the traction circuit.

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Rear Wheel Motors (Machines with Optional CrossTrax™ Kit)

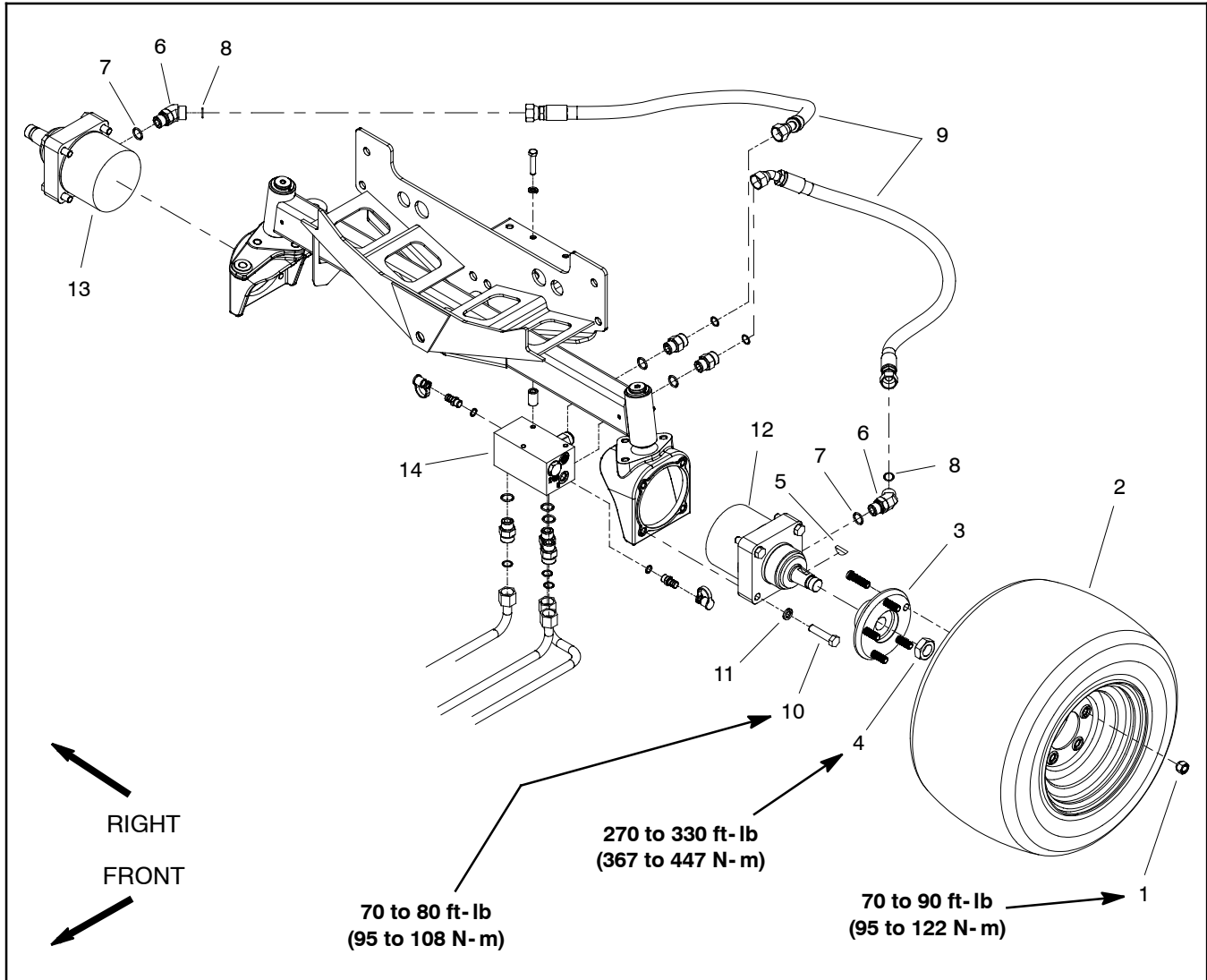


Figure 67

- | | | |
|-------------------------------|--|---------------------------------|
| 1. Lug nut (5 used per wheel) | 6. 45° hydraulic fitting (2 per motor) | 11. Lock washer (4 per motor) |
| 2. Rear wheel assembly | 7. O-ring | 12. LH rear wheel motor |
| 3. Wheel hub assembly | 8. O-ring | 13. RH rear wheel motor |
| 4. Lock nut | 9. Hydraulic hose (4 used) | 14. CrossTrax™ control manifold |
| 5. Woodruff key | 10. Cap screw (4 per motor) | |

Removal (Fig. 67)

1. Park the machine on a level surface, lower the cutting units and stop the engine. Remove the key from the ignition switch.

2. Chock rear wheels to prevent machine from moving or shifting.

3. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

4. Loosen, but do not remove, lock nut (item 4) from rear wheel motor shaft.

5. Remove rear wheel from machine (see Wheels in the Service and Repairs section of Chapter 6 - Chassis).

6. Remove wheel hub from rear wheel motor:

IMPORTANT: DO NOT hit wheel hub, puller or wheel motor with a hammer during wheel hub removal or installation. Hammering may cause damage to the wheel motor.

A. Make sure that lock nut (item 4) on wheel motor shaft is loose. Use hub puller (see Special Tools in this chapter) to loosen wheel hub from wheel motor shaft.

B. Remove lock nut and wheel hub from wheel motor shaft. Locate and retrieve woodruff key (item 5).



7. Thoroughly clean hydraulic hose ends and fittings on wheel motor to prevent hydraulic system contamination.

8. Label hydraulic connections at wheel motor for assembly purposes.

9. Disconnect hydraulic hoses from fittings on wheel motor. Allow hoses to drain into a suitable container.

10. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

NOTE: Right and left rear wheel motors are the same basic design with some minor differences. The left side wheel motor is identified with a yellow dot on the motor housing near the B port. If both motors are removed from the machine, label motors for assembly purposes.

11. Support wheel motor to prevent it from falling. Remove four (4) cap screws and lock washers that secure motor to housing.

12. Remove rear wheel motor from machine.

13. If hydraulic fittings are to be removed from wheel motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

Installation (Fig. 67)

1. If fittings were removed from wheel motor, lubricate and place new O-rings to fittings. Install fittings into motor ports using marks made during the removal process to properly orientate fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position rear wheel motor to housing. Secure wheel motor to housing with four (4) cap screws and lock washers. Torque cap screws from **70 to 80 ft-lb (95 to 108 N-m)**.

3. Remove caps and plugs from disconnected hydraulic hoses and fittings.

4. Lubricate and position new O-rings to fittings on wheel motor. Use labels placed during the removal process to properly install and secure hydraulic hoses to wheel motor fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter)

IMPORTANT: Before wheel hub is installed, thoroughly clean tapers of wheel hub and wheel motor shaft. Make sure that tapers are free of grease, oil and dirt. DO NOT use antiseize lubricant when installing wheel hub.

5. Install woodruff key (item 5) and then wheel hub (item 3) to wheel motor shaft. Secure wheel hub to the wheel motor shaft with lock nut (item 4).

6. Install rear wheel to machine (see Wheels in the Service and Repairs section of Chapter 6 - Chassis).

7. Make sure that wheel hub lock nut (item 5) is tightened from **270 to 330 ft-lb (367 to 447 N-m)** and wheel lug nuts are tightened from **70 to 90 ft-lb (95 to 122 N-m)**.

8. Check and adjust oil level in hydraulic reservoir.

IMPORTANT: If a rear wheel motor failure occurred, refer to Traction Circuit Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

9. Operate machine functions slowly until air is out of system (see Charge Hydraulic System in this section).

Rear Wheel Motor Service (Machines with Optional CrossTrax™ Kit)

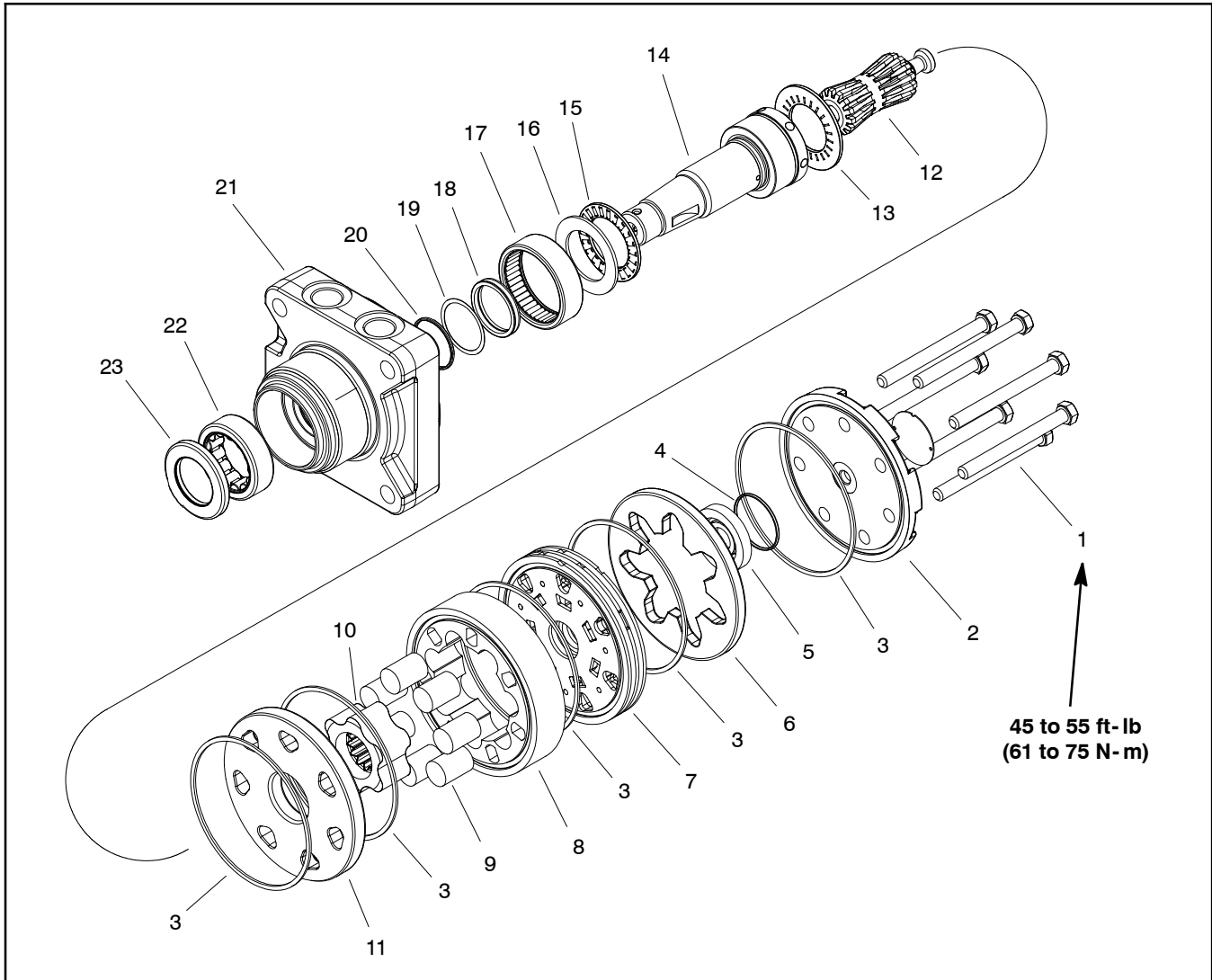


Figure 68

- | | | |
|-----------------------|--------------------|-------------------------|
| 1. Cap screw (7 used) | 9. Vane (7 used) | 17. Inner bearing |
| 2. End cover | 10. Rotor | 18. Shaft seal |
| 3. Body seal (5 used) | 11. Wear plate | 19. Back-up washer |
| 4. Commutator ring | 12. Drive link | 20. Back-up ring |
| 5. Commutator | 13. Thrust bearing | 21. Housing |
| 6. Commutator ring | 14. Coupling shaft | 22. Outer bearing |
| 7. Manifold | 15. Thrust bearing | 23. Dirt and water seal |
| 8. Stator | 16. Thrust washer | |

NOTE: The rear wheel motors used on machines with the optional CrossTrax™ Kit are Parker Torqmotor™ motors of the same basic design with minor differences. The right side motor has a reverse timed manifold to allow correct rotation direction for forward and reverse. The left side wheel motor is identified with a yellow dot on the motor housing near the B port.

NOTE: For Parker wheel motor repair procedures, see the Parker Torqmotor™ Service Procedure (TC, TB, TE, TJ, TF, TG, TH and TL Series) at the end of this chapter.

IMPORTANT: If a wheel motor failure occurred, refer to **Traction Circuit Component Failure** in the **General Information** section for information regarding the importance of removing contamination from the traction circuit.

Control Manifold Cartridge Valve Service

1. Make sure the control manifold is clean before removing the cartridge valve from the control manifold.

2. If cartridge valve is solenoid operated, remove nut securing solenoid coil to the cartridge valve. Carefully slide coil off the valve.

IMPORTANT: Use care when handling the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction. When removing cartridge valve from manifold, make sure that deep well socket fully engages the valve base.

3. Remove cartridge valve from manifold using a deep socket wrench. Note correct location for O-rings, sealing rings and backup rings. Remove seal kit from cartridge valve and discard removed seals.

4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads and contamination.

5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.

A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.

B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. If cartridge design allows, use a wood or plastic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Be extremely careful to not damage cartridge. Use compressed air for cleaning.

7. Install the cartridge valve into the manifold:

A. Lubricate new seal kit components with clean hydraulic oil and install on valve. The O-rings, sealing rings and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.

B. Dip assembled cartridge into clean hydraulic oil.

IMPORTANT: Use care when handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction. When installing cartridge valve into manifold, make sure that deep well socket fully engages the valve base.

C. Thread cartridge valve carefully into manifold port by hand until the top O-ring is met. The valve should go into manifold port easily without binding.

D. Torque cartridge valve using a deep socket wrench to value identified in control manifold illustration.

8. If cartridge valve is solenoid operated, carefully install solenoid coil to the cartridge valve. Secure coil to valve with nut and torque nut to **60 in-lb (6.8 N-m)**.

9. If problems still exist after assembly, remove valve and clean again or replace valve.



CAUTION

Use eye protection such as goggles when using compressed air for cleaning manifold components.

Lift Control Manifold

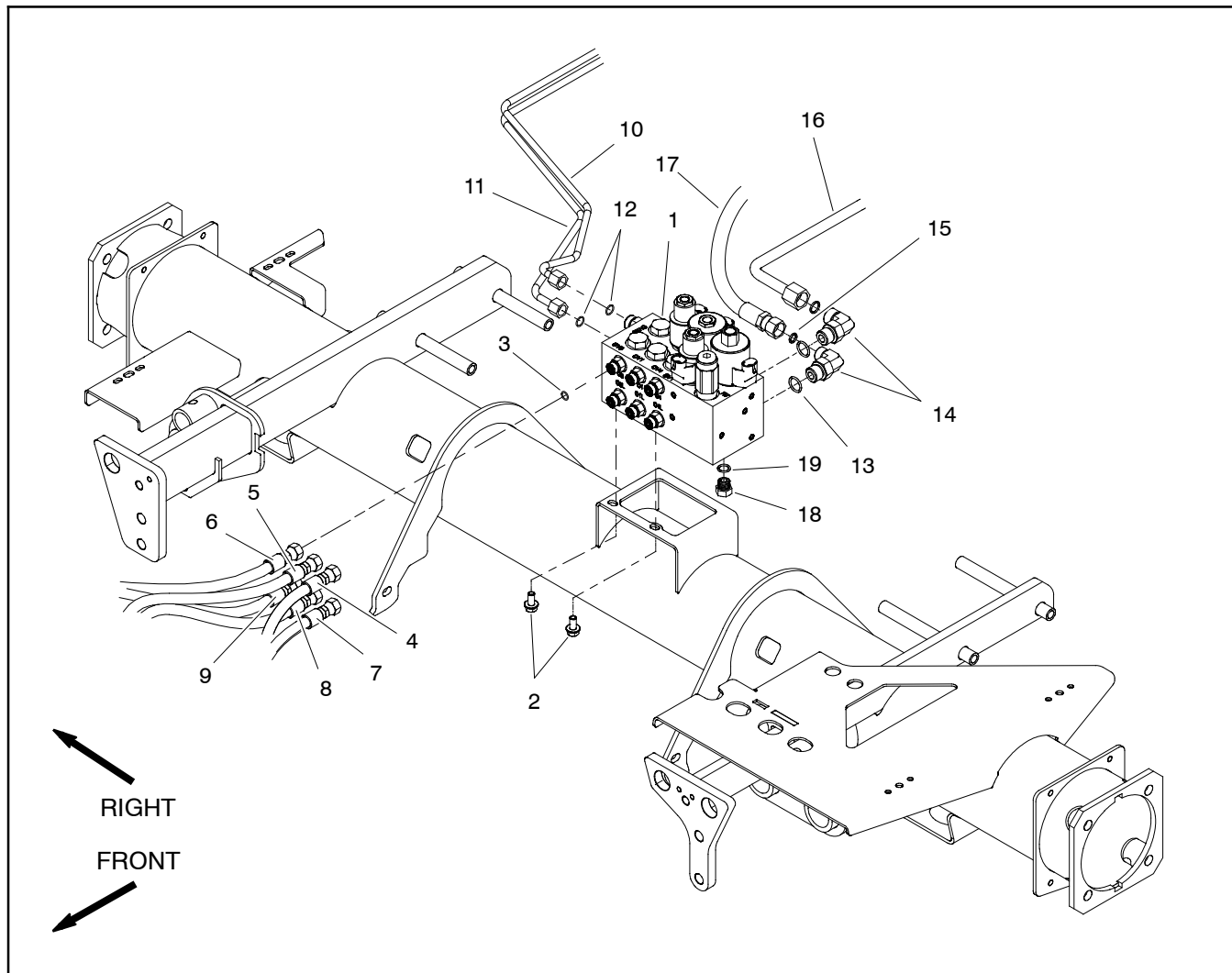
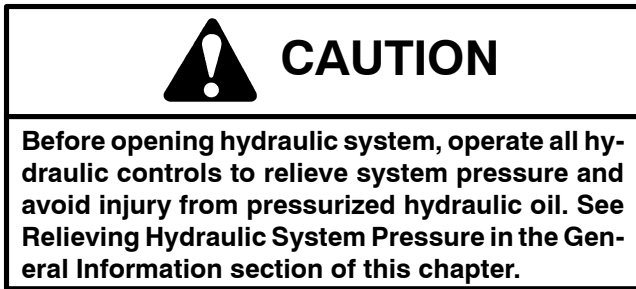


Figure 69

- | | | |
|--------------------------|--------------------|------------------------------------|
| 1. Lift control manifold | 8. Hydraulic hose | 14. 90° hydraulic fitting (2 used) |
| 2. Flange head screw | 9. Hydraulic hose | 15. O-ring |
| 3. O-ring | 10. Hydraulic tube | 16. Hydraulic tube |
| 4. Hydraulic hose | 11. Hydraulic tube | 17. Hydraulic hose |
| 5. Hydraulic hose | 12. O-ring | 18. Plug |
| 6. Hydraulic hose | 13. O-ring | 19. O-ring |
| 7. Hydraulic hose | | |

Removal (Fig. 69)

1. Park the machine on a level surface, engage parking brake, lower cutting units and stop engine. Remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
3. Locate hydraulic lift control manifold that is attached to frame bracket under the front platform.
4. Label all hydraulic connections for assembly purposes. Thoroughly clean hydraulic connections prior to loosening hydraulic lines.



5. Disconnect hydraulic hoses and tubes from fittings in manifold. Allow lines to drain into a suitable container. Remove and discard O-rings.
6. Put caps or plugs on disconnected hydraulic lines and fittings to prevent contamination.
7. Label all solenoid coil wire harness leads for assembly purposes. Unplug wire harness leads from solenoid coils on manifold.
8. Remove two (2) flange head screws that secure manifold to machine frame.
9. Remove lift control manifold from machine.

IMPORTANT: A flow control orifice is placed beneath several hydraulic fittings on the lift control manifold (Fig. 70). The lift manifold uses three (3) different orifice sizes. If fittings are removed from manifold and an orifice is in the manifold port, make sure to remove orifice and label its position for assembly purposes.

10. If necessary, remove hydraulic fittings from manifold. Discard any removed O-rings. Locate, retrieve and label orifice from manifold ports (if equipped).

Installation (Fig. 69)

1. If fittings were removed from manifold:
 - A. Lubricate new O-rings with clean hydraulic oil. Install lubricated O-rings on fittings.

IMPORTANT: When installing orifice in manifold (Fig. 70), make sure that orifice is flat in the base of the fitting cavity. Manifold damage is possible if the orifice is cocked in the cavity.

- B. For manifold ports with orifice, place correct orifice in port with the orifice slot facing out.
 - C. Install fittings into manifold (see Hydraulic Fitting Installation in the General Information section of this chapter). Torque fittings to torque values identified in Figure 70.
2. Position lift control manifold to frame. Install two (2) flange head screws but do not fully tighten.
 3. Remove caps and plugs from hydraulic lines and fittings.
 4. Lubricate and install new O-ring(s) on manifold fittings. Connect and tighten hydraulic lines to hydraulic manifold fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter)
 5. Secure hydraulic manifold to frame by tightening two (2) flange head screws.
 6. Connect wire harness leads to solenoid coils on manifold using labels placed during removal.
 7. Check oil level in hydraulic reservoir and add correct oil if necessary.
 8. Follow Hydraulic System Start-up procedures (see Hydraulic System Start-up in this section).

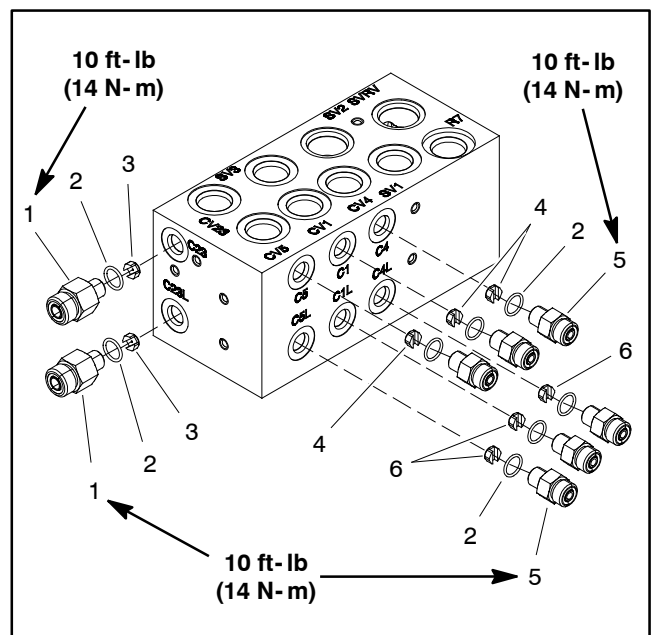


Figure 70

- | | |
|---------------------|---------------------|
| 1. Fitting (2 used) | 4. Orifice (0.028) |
| 2. O-ring | 5. Fitting (6 used) |
| 3. Orifice (0.046) | 6. Orifice (0.055) |

For lift control manifold service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 71 for cartridge valve installation torque. Refer to Figures 71 and 72 for hydraulic fitting installation torque values.

NOTE: Solenoid valves SV1 and SV2 on the lift control manifold use a coil spacer between the solenoid coil and nut.

NOTE: Adjustment of Relief Valve (R7) is NOT recommended.

IMPORTANT: A flow control orifice is placed beneath several of the hydraulic fittings on the lift control manifold (Fig. 72). The lift manifold uses three (3) different orifice sizes. If a fitting is removed from the lift control manifold and an orifice is in the manifold port, make sure to remove orifice and label its position for assembly purposes.

IMPORTANT: When installing orifice in manifold (Fig. 72), make sure that orifice is flat in the base of the fitting cavity. Manifold damage is possible if the orifice is cocked in the cavity.

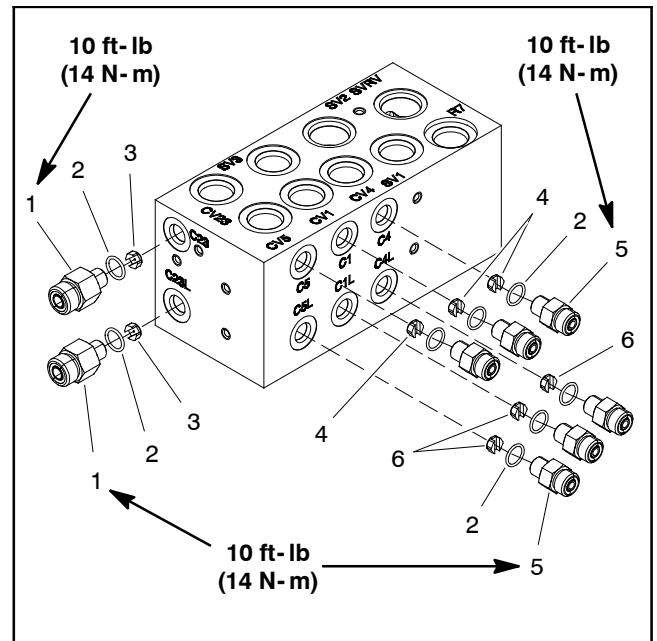


Figure 72

- | | |
|---------------------|---------------------|
| 1. Fitting (2 used) | 4. Orifice (0.028) |
| 2. O-ring | 5. Fitting (6 used) |
| 3. Orifice (0.046) | 6. Orifice (0.055) |

CrossTrax™ AWD Manifold (Machines with Optional CrossTrax™ Kit)

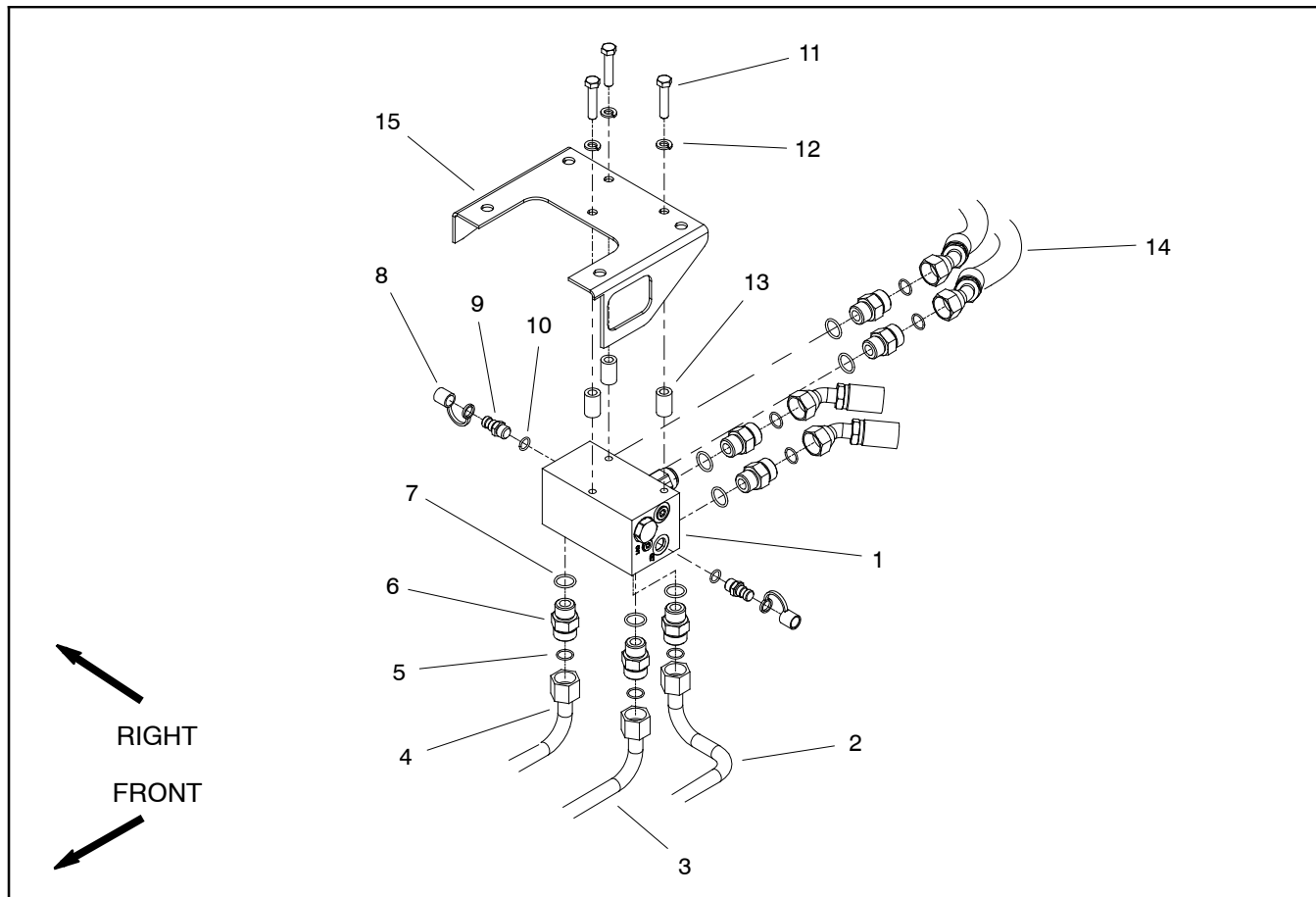


Figure 73

- | | | |
|---------------------------|--------------------------------|-----------------------------|
| 1. CrossTrax AWD manifold | 6. Hydraulic fitting (7 used) | 11. Cap screw (3 used) |
| 2. Hydraulic tube | 7. O-ring | 12. Lock washer (3 used) |
| 3. Hydraulic tube | 8. Dust cap (2 used) | 13. Spacer (3 used) |
| 4. Hydraulic tube | 9. Diagnostic fitting (2 used) | 14. Hydraulic hose (4 used) |
| 5. O-ring | 10. O-ring | 15. Frame bracket |

Removal (Fig. 73)

1. Park the machine on a level surface, engage parking brake, lower cutting units and stop engine. Remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
3. Locate CrossTrax™ AWD manifold that is attached to bracket at rear of frame.
4. Label all hydraulic connections for assembly purposes. Thoroughly clean hydraulic connections prior to loosening hydraulic lines.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

5. Disconnect hydraulic hoses and tubes from fittings in manifold. Allow lines to drain into a suitable container. Remove and discard O-rings.

6. Put caps or plugs on disconnected lines and fittings to prevent contamination.

7. Support manifold to prevent it from falling. Remove three (3) cap screws and lock washers that secure manifold to machine frame. Locate and retrieve three (3) spacers from between frame bracket and manifold.

8. Remove AWD manifold from machine.

9. If necessary, remove hydraulic fittings from manifold. Discard any removed O-rings.

Installation (Fig. 73)

1. If fittings were removed from AWD manifold, lubricate and place new O-rings to fittings. Install fittings into manifold (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position manifold and three (3) spacers to frame bracket. Install three (3) lock washers and cap screws but do not fully tighten.

3. Remove caps and plugs from disconnected hydraulic lines and fittings.

4. Lubricate and install new O-ring(s) on manifold fittings. Connect hydraulic lines to hydraulic manifold fittings. Properly tighten all connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Secure AWD manifold to frame by tightening three (3) cap screws.

6. Check oil level in hydraulic reservoir and add correct oil if necessary.

7. Follow hydraulic system start-up procedures (see Hydraulic System Start-up in this section).

CrossTrax™ AWD Manifold Service (Machines with Optional CrossTrax™ Kit)

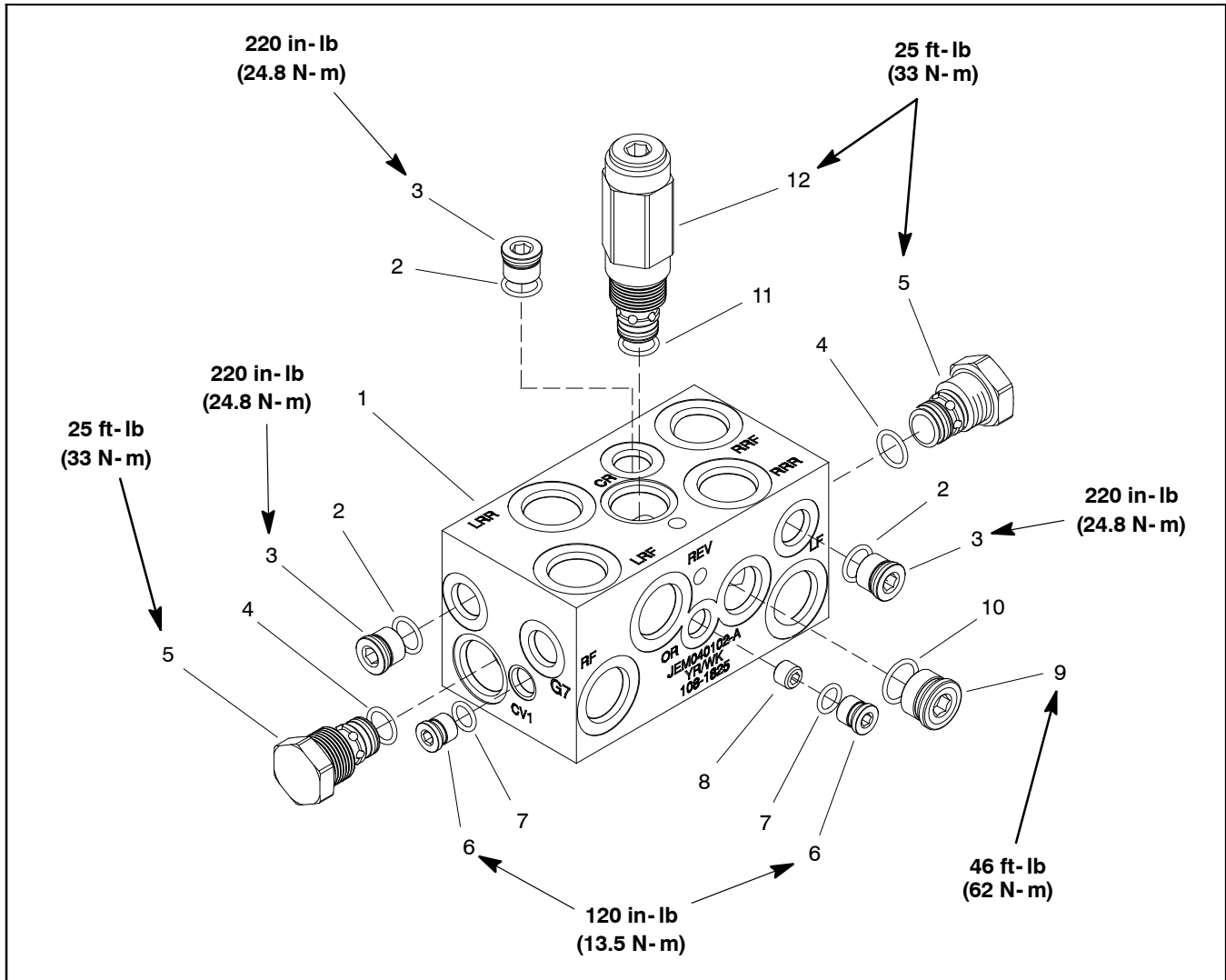


Figure 74

- | | | |
|---------------------------|-------------------|---------------------------------|
| 1. CrossTrax AWD manifold | 5. Check valve | 9. Plug (NWD #8) |
| 2. O-ring | 6. Plug (NWD #4) | 10. O-ring |
| 3. Plug (NWD #6) | 7. O-ring | 11. Seal kit |
| 4. Seal kit | 8. Orifice (.040) | 12. Bi-Directional relief valve |

For CrossTrax™ AWD control manifold service procedures, see Control Manifold Cartridge Valve Service in this section. Refer to Figure 74 for cartridge valve and plug installation torque.

NOTE: Adjustment of bi-directional relief valve (item 12) is NOT recommended.

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Lift Cylinders

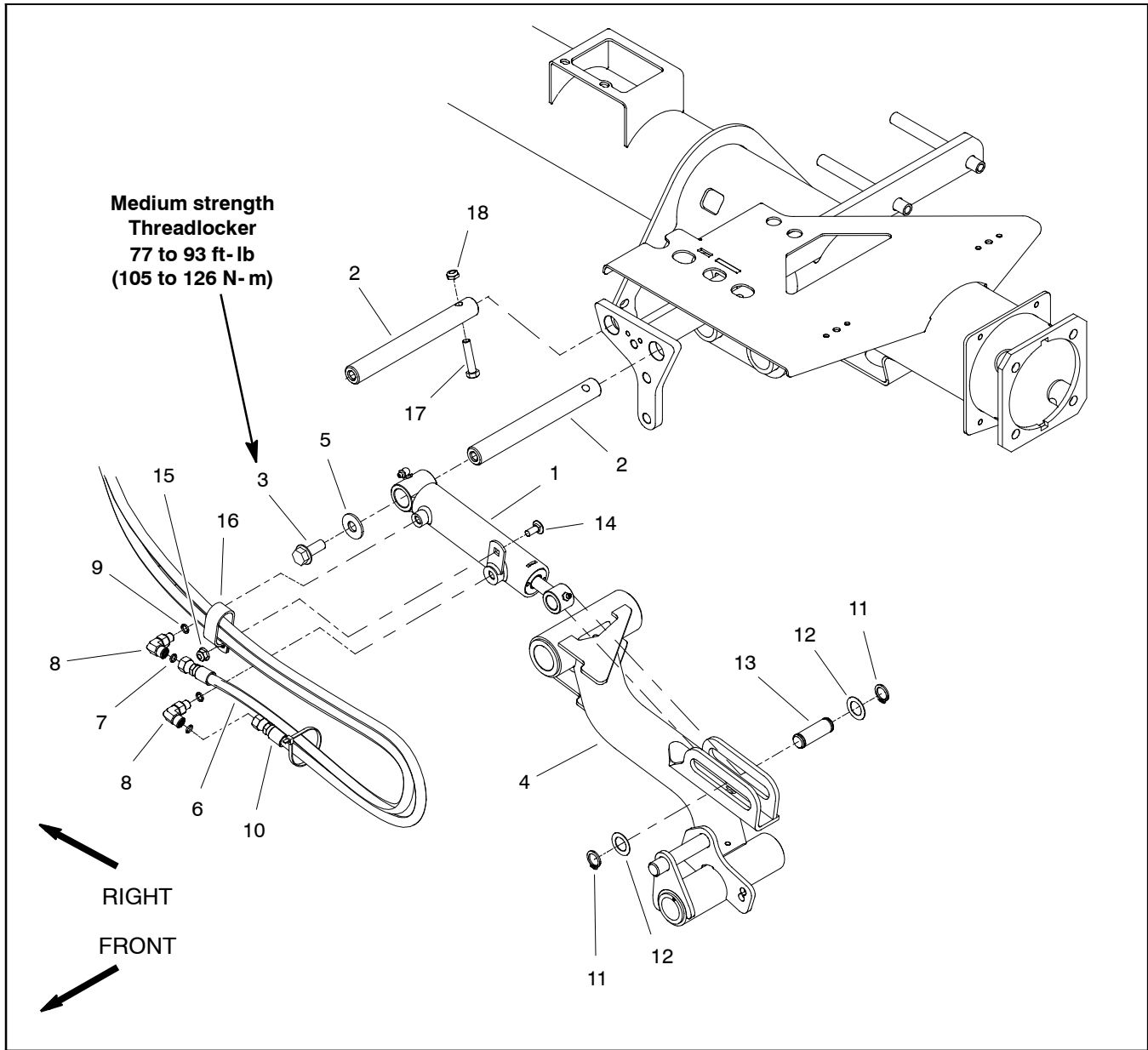



Figure 75

- | | | |
|------------------------|--------------------------|------------------------|
| 1. Lift cylinder | 7. O-ring | 13. Cylinder slide pin |
| 2. Cylinder pin | 8. 90° hydraulic fitting | 14. Carriage screw |
| 3. Flange head screw | 9. O-ring | 15. Flange nut |
| 4. Lift arm (#4 shown) | 10. Hydraulic hose | 16. R-clamp |
| 5. Flat washer | 11. Retaining ring | 17. Cap screw |
| 6. Hydraulic hose | 12. Thrust washer | 18. Lock nut |

NOTE: The procedure for lift cylinder removal and installation is the same for all Reelmaster 5010- H lift cylinders. Figure 75 shows the lift cylinder for the #4 cutting unit (left front).


Removal (Fig. 75)

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. To prevent unexpected cutting unit operation, disconnect the cutting units from the electrical power supply by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).
3. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
4. Label all hydraulic connections for assembly purposes. Thoroughly clean hydraulic connections prior to loosening hydraulic lines from lift cylinder.
5. If lift cylinder for outside front cutting units (#4 or #5) is being removed, remove flange nut and carriage screw that secure the hydraulic hose R- clamp to lift cylinder.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.



WARNING

Make sure that cutting units are fully lowered before loosening hydraulic lines from lift cylinders. If cutting units are not fully lowered as hydraulic lines are loosened, the cutting units may drop unexpectedly.

6. Disconnect hydraulic hoses from fittings in lift cylinder that is to be removed. Allow hoses to drain into a suitable container. Remove and discard O- rings.
7. Put caps or plugs on disconnected hoses and fittings to prevent contamination.
8. Remove one retaining ring (item 11) and thrust washer (item 12) from the cylinder slide pin (item 13) that secures lift cylinder to lift arm. Pull slide pin from the lift cylinder and lift arm. Locate and retrieve second thrust washer.

9. Remove flange head screw (item 3) and flat washer (item 5) that retain lift cylinder to cylinder pin.
10. Slide lift cylinder from cylinder pin and remove from machine.
11. If hydraulic fittings are to be removed from lift cylinder, mark fitting orientation to allow correct assembly. Remove fittings from lift cylinder and discard O- rings.

Installation (Fig. 75)

1. If hydraulic fittings were removed from lift cylinder, lubricate new O- rings, position O- rings to fittings and install fittings into lift cylinder ports (see Hydraulic Fitting Installation in the General Information section of this chapter). Make sure that fittings are orientated correctly.
2. Position lift cylinder to the frame with the barrel end up.
3. Slide lift cylinder clevis onto cylinder pin.
4. Apply medium strength threadlocker to threads of flange head screw (item 3). Secure cylinder with flange head screw (item 3) and flat washer (item 5). Torque screw from **77 to 93 ft- lb (105 to 126 N- m)**.
5. Align lift cylinder to lift arm mounting slot. Slide cylinder slide pin (item 13) with retaining ring (item 12) and thrust washer (item 12) through the lift arm and lift cylinder. Install second thrust washer on pin and secure with second retaining ring.
6. Remove caps and plugs from disconnected hoses and fittings.
7. Coat new O- rings lightly with clean hydraulic oil, install new O- rings and connect hydraulic hoses to fittings on lift cylinder. Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
8. Check oil level in hydraulic reservoir and add correct oil if necessary.
9. Lubricate lift cylinder grease fittings.
10. Plug the cutting unit power disconnect connector back in before operating the machine.
11. Follow hydraulic system start- up procedures (see Hydraulic System Start- up in this section).

Lift Cylinder Service

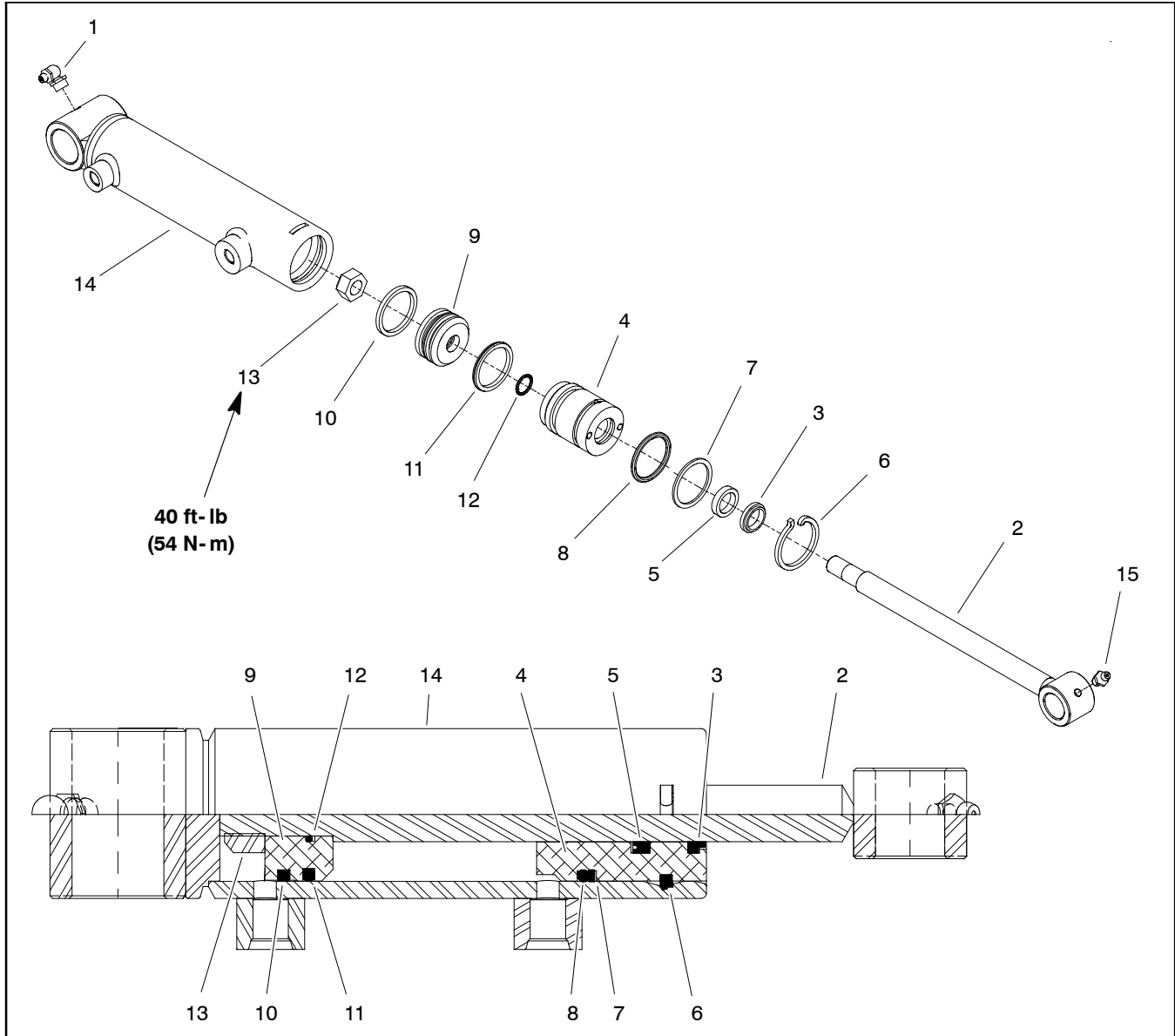


Figure 76

- | | | |
|-------------------|-------------------|--------------------|
| 1. Grease fitting | 6. Retaining ring | 11. BP seal |
| 2. Shaft | 7. Back up washer | 12. O-ring |
| 3. Dust seal | 8. O-ring | 13. Lock nut |
| 4. Head | 9. Piston | 14. Barrel |
| 5. BS seal | 10. Wear ring | 15. Grease fitting |

NOTE: The front, outside lift cylinders are longer with more stroke than the other lift cylinders which are identical. Service procedures for all lift cylinders used on Reelmaster 5010- H machines are the same.

Disassembly (Fig. 76)

1. Remove oil from lift cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT: Prevent damage when clamping the lift cylinder into a vise; clamp on the clevis end of the barrel **ONLY**.

2. Mount lift cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.

3. Using a spanner wrench, rotate head clockwise until the edge of the retaining ring appears in the barrel opening. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening. Rotate the head counter-clockwise to remove retaining ring from barrel and head.

4. Remove plugs from ports. Extract shaft, head and piston by carefully twisting and pulling on the shaft.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Clamp on the clevis ONLY.

5. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Carefully slide head off the shaft.

6. Taking care to not scratch or damage the piston, remove wear ring, BP seal and O-ring from the piston.

7. Taking care to not scratch or damage the head, remove O-ring, back-up washer, dust seal and BS seal from the head.

8. Discard removed seals and O-rings.

Inspection



1. Wash all lift cylinder components in solvent. Dry parts with compressed air.

2. Inspect internal surface of barrel for deep scratches, out-of-roundness and bending.

3. Inspect head, shaft and piston for excessive pitting, scoring and wear.

4. Replace lift cylinder if internal components are found to be worn or damaged.

Assembly (Fig. 76)

1. Make sure all lift cylinder parts are clean before assembly.

2. Coat new O-rings, back-up washer and other seals with clean hydraulic oil.

A. Carefully install wear ring, BP seal and O-ring to the piston.

B. Carefully install back-up washer, O-ring, dust seal and BS seal to the head.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Clamp on the clevis ONLY.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.

A. Coat shaft with clean hydraulic oil.

B. Slide head assembly onto the shaft.

C. Install piston assembly onto the shaft and secure with lock nut. Torque lock nut **40 ft-lb (54 N-m)**.

D. Remove shaft assembly from the vise.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis end of the barrel ONLY.

4. Mount barrel securely in a vise by clamping on the clevis end of the barrel.

IMPORTANT: When installing the head into the barrel, pay careful attention to the retaining ring slot in the barrel to insure that the piston and head seals do not lodge in the slot.

5. Coat all internal parts with a light coat of clean hydraulic oil. Slide piston, shaft and head assembly into the barrel being careful not to damage the seals.

6. Secure head in barrel by installing retaining ring.

A. Align retaining ring hole in the head with the access slot in the barrel.

B. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.

Steering Control Valve

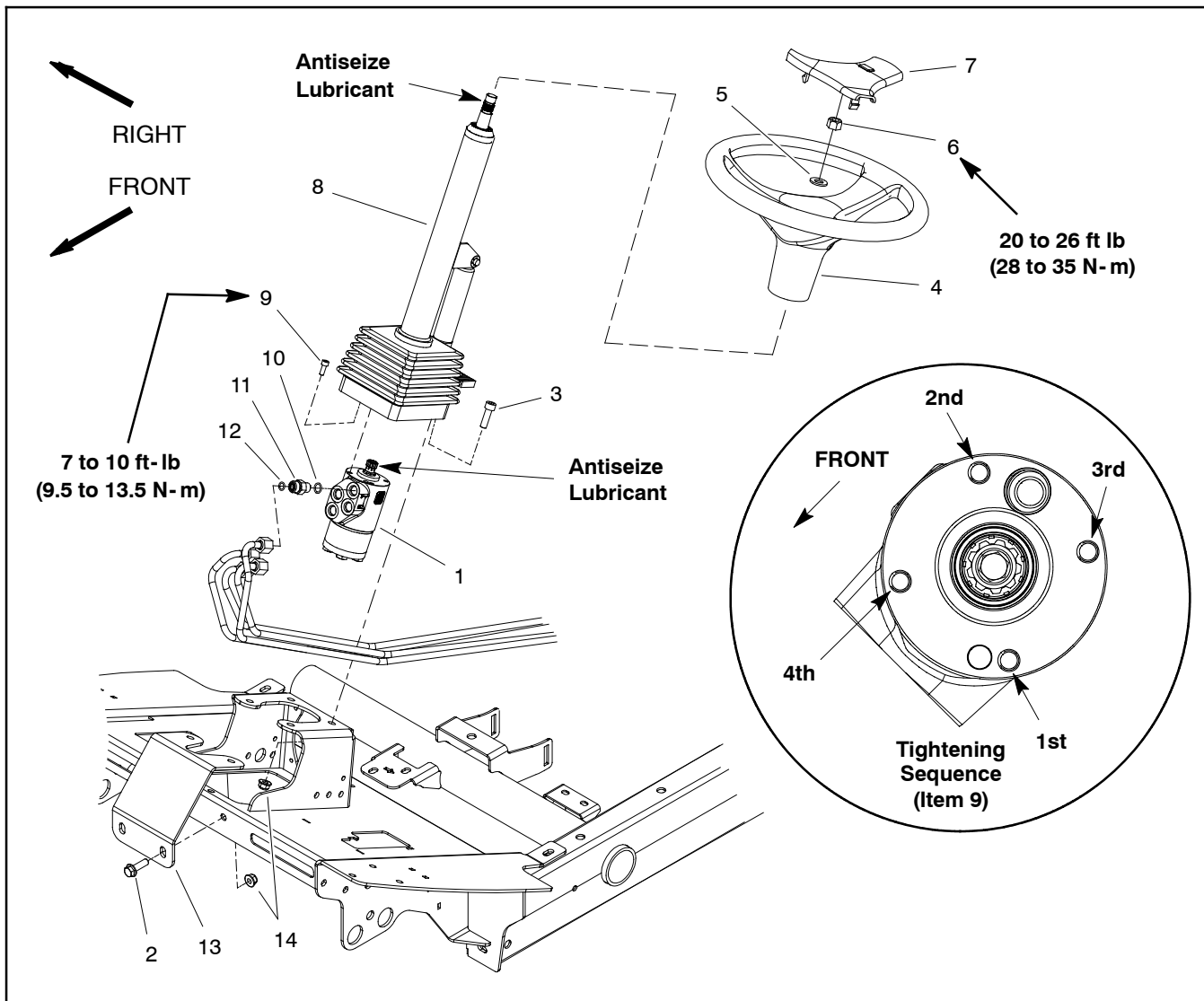


Figure 77

- | | | |
|-------------------------------|-------------------------------|--------------------------------|
| 1. Steering control valve | 6. Lock nut | 11. Hydraulic fitting (4 used) |
| 2. Flange head screw (2 used) | 7. Steering wheel cover | 12. O-ring |
| 3. Socket head screw (4 used) | 8. Steering column | 13. Steering column brace |
| 4. Steering wheel | 9. Socket head screw (4 used) | 14. Flange nut (6 used) |
| 5. Flat washer | 10. O-ring | |

Removal (Fig. 77)

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Remove fasteners that secure shroud to front of machine (Fig. 78). Remove shroud from machine to allow access to steering control valve. Locate and retrieve two (2) rubber bushings and spacers.
3. Slide rubber bellows up from bottom of steering column. Support steering column to prevent it from falling.
4. Loosen and remove four (4) flange head screws and flange nuts that secure steering column brace (item 13) to machine. Remove brace.
5. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
6. Label all hydraulic connections for assembly purposes. Note port designations on steering control valve (Fig. 79). Thoroughly clean hydraulic connections prior to loosening hydraulic lines.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

7. Disconnect hydraulic lines from steering control valve. Allow lines to drain into a suitable container.
8. Put caps or plugs on disconnected lines and fittings to prevent contamination.
9. Remove two (2) socket head screws and flange nuts that secure steering column to machine.
10. Remove steering column assembly with steering control valve attached from machine.
11. Loosen and remove four (4) socket head screws that secure steering control valve to steering column.
12. Remove steering control valve from steering column.
13. If necessary, remove fittings and O-rings from steering control valve. Discard all removed O-rings.

Installation (Fig. 77)

1. If fittings were removed, lubricate new O-rings with clean hydraulic oil and install fittings to steering control valve (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Apply antiseize lubricant to splines of steering control valve shaft.
3. Slide steering control valve shaft into steering column universal joint. Position control valve with ports toward front of machine. Secure steering control valve to steering column with four (4) socket head screws. Hand tighten screws in the sequence shown in Figure 77. Then, using the same sequence, torque screws from **7 to 10 ft-lb (9.5 to 13.5 N-m)**.
4. Position steering column assembly to machine. Secure steering column in place with two (2) socket head screws and flange nuts at rear two mounting holes.
5. Remove caps and plugs from disconnected lines and fittings.
6. Lubricate new O-rings and connect hydraulic lines to fittings on steering control valve. Tighten connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Position steering column brace (item 13) to machine and secure with four (4) flange head screws and flange nuts.
8. Slide rubber bellows to bottom of steering column.
9. Place rubber bushings and spacers into holes of shroud (Fig. 78). Position shroud in place and secure with removed fasteners.
10. Check oil level in hydraulic reservoir and add correct oil if necessary.
11. Follow Hydraulic System Start-up procedures (see Hydraulic System Start-up in this section).

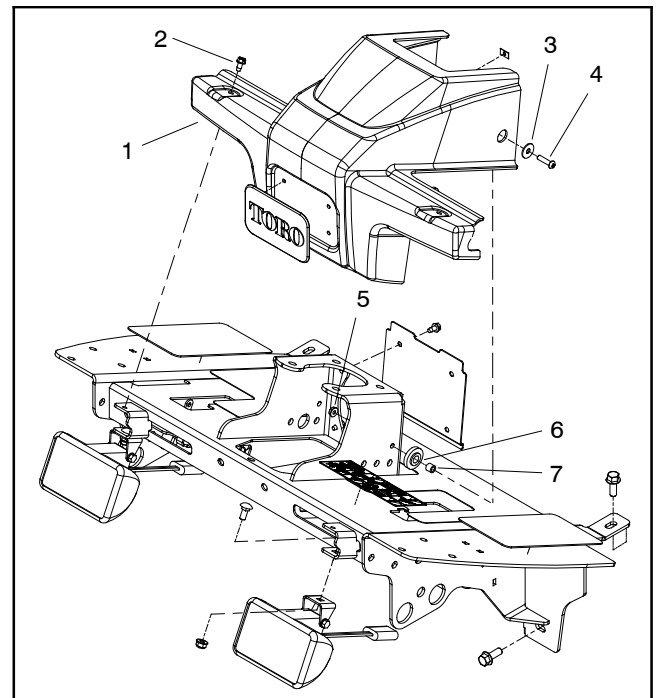


Figure 78

- | | |
|----------------------------|----------------------------|
| 1. Shroud | 5. Lock nut (2 used) |
| 2. Screw (2 used) | 6. Rubber bushing (2 used) |
| 3. Flat washer (2 used) | 7. Spacer (2 used) |
| 4. Phillips screw (2 used) | |

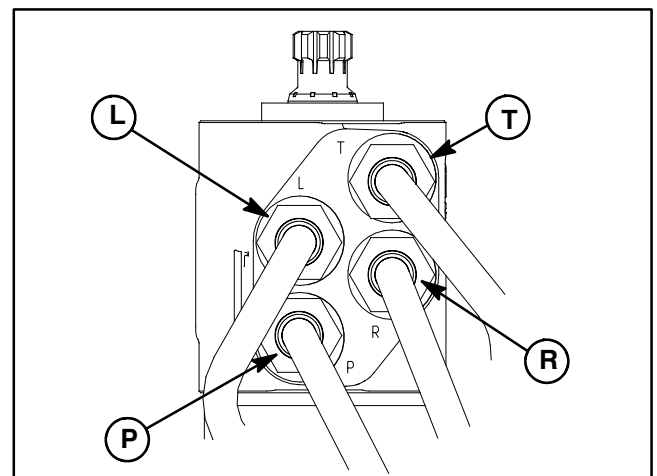


Figure 79

Steering Control Valve Service

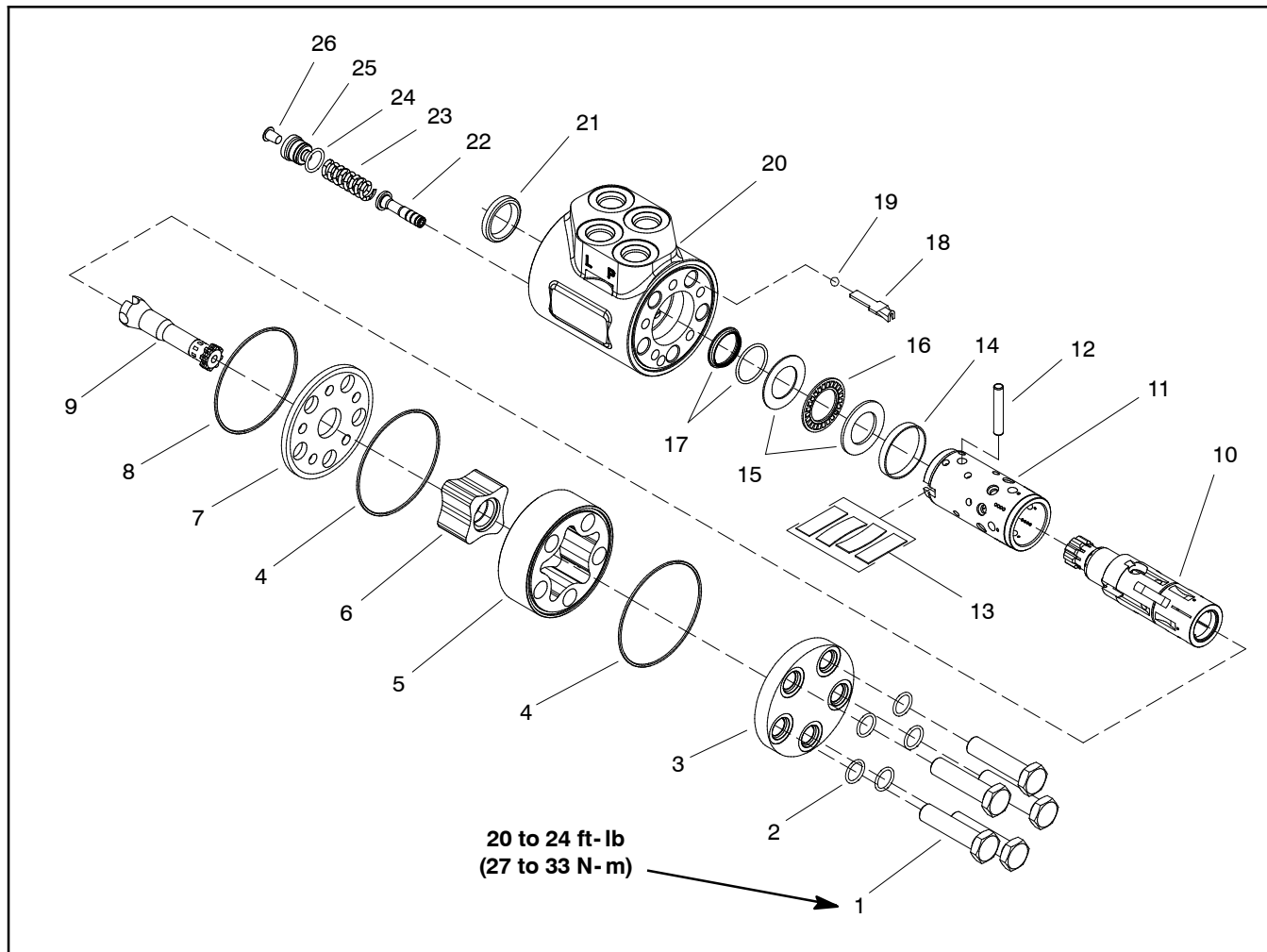


Figure 80

- | | | |
|----------------------|-------------------|--------------------|
| 1. Screw (5 used) | 10. Spool | 19. Check ball |
| 2. O-ring (5 used) | 11. Sleeve | 20. Housing |
| 3. End cover | 12. Cross pin | 21. Dust seal ring |
| 4. O-ring | 13. Spring set | 22. Relief valve |
| 5. Outer gearwheel | 14. Ring | 23. Spring |
| 6. Inner gearwheel | 15. Thrust washer | 24. O-ring |
| 7. Distributor plate | 16. Bearing | 25. Plug |
| 8. O-ring | 17. Shaft seal | 26. Plug |
| 9. Cardan shaft | 18. Ball stop | |

NOTE: For repair of the steering control valve, see the Sauer-Danfoss Steering Unit Type OSPM Service Manual at the end of this chapter.

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Steering Cylinder

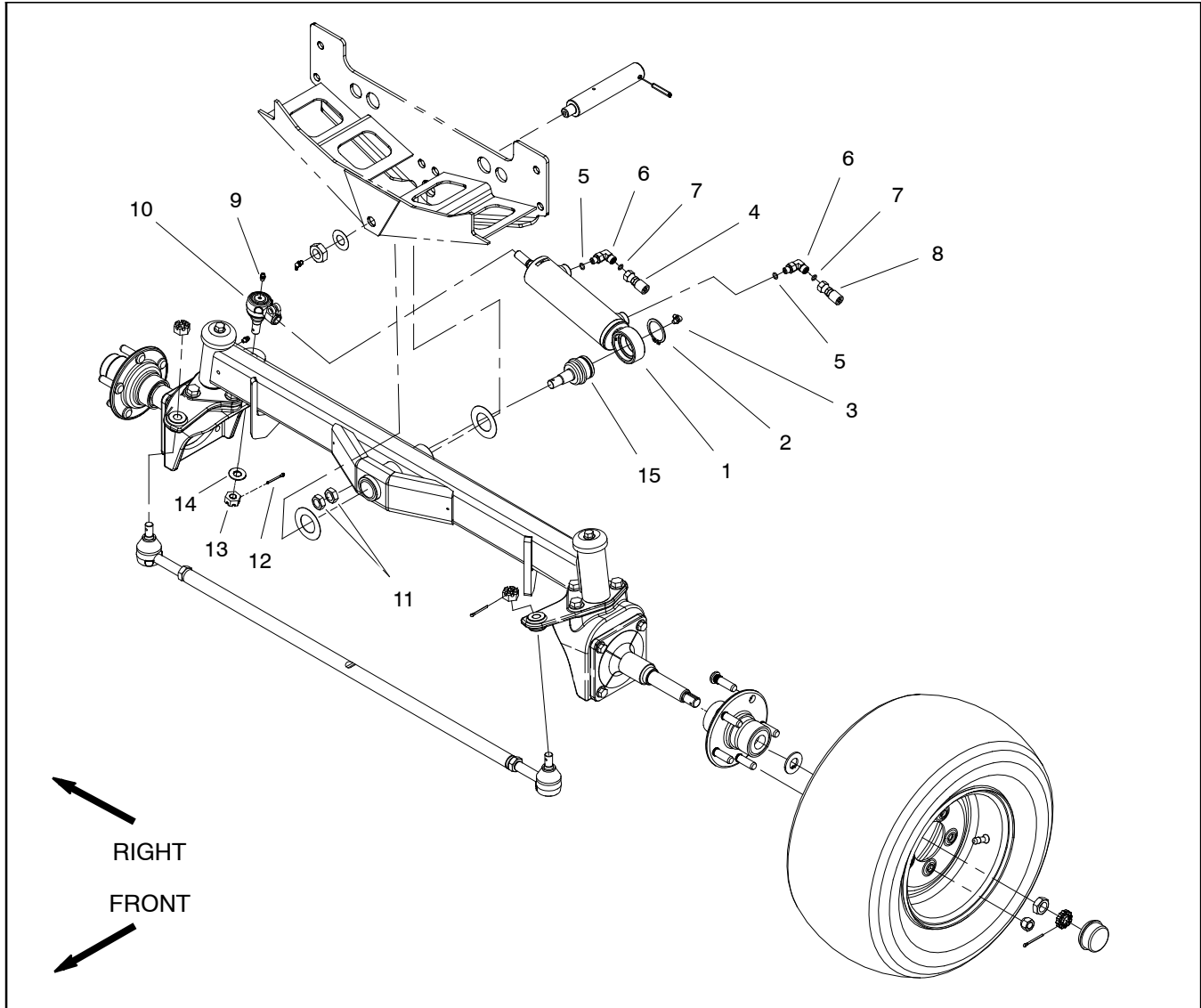


Figure 81

- | | | |
|----------------------|--------------------------|---------------------|
| 1. Steering cylinder | 6. 90° hydraulic fitting | 11. Jam nut |
| 2. Retaining ring | 7. O-ring | 12. Cotter pin |
| 3. Grease fitting | 8. Hydraulic hose | 13. Slotted hex nut |
| 4. Hydraulic hose | 9. Grease fitting | 14. Washer |
| 5. O-ring | 10. Ball joint | 15. Ball joint |

Removal (Fig. 81)

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.



CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

3. Label all hydraulic connections for assembly purposes. Thoroughly clean hydraulic hose ends prior to disconnecting hoses from the steering cylinder.
4. Disconnect hydraulic hoses from fittings in steering cylinder.
5. Put caps or plugs on disconnected hoses and fittings to prevent contamination.
6. Remove two (2) jam nuts (item 11) that secure steering cylinder to axle. Remove cotter pin (item 12), washer (item 14) and slotted hex nut (item 13) that secure steering cylinder to RH drag link.
7. Separate ball joints from axle assembly and remove steering cylinder from machine.
8. If necessary, remove ball joints from steering cylinder barrel and shaft (Fig. 82). If ball joint is to be removed from cylinder shaft, fully retract cylinder shaft and measure center to center length to ease installation of ball joint onto cylinder shaft (Fig. 83).
9. If hydraulic fittings are to be removed from steering cylinder, mark fitting orientation to allow correct assembly. Remove fittings from steering cylinder and discard O-rings.

Installation (Fig. 81)

1. If hydraulic fittings were removed from steering cylinder, lubricate new O-rings with clean hydraulic oil, position O-rings to fittings and install fittings into steering cylinder ports (see Hydraulic Fitting Installation in the General Information section of this chapter). Make sure that fittings are orientated correctly.
2. If removed, press ball joint into barrel and secure with retaining ring. Make sure that retaining ring is fully seated in groove in steering cylinder barrel.
3. If ball joint was removed from cylinder shaft, fully retract cylinder shaft and thread ball joint onto shaft so that center to center length is as measured during removal process. Tighten clamp bolt and nut.
4. Thoroughly clean tapers on ball joints and axle assembly.
5. Position steering cylinder to machine.
6. Secure steering cylinder to axle with jam nuts (item 11). Tighten first jam nut and then, while holding first jam nut with wrench, tighten second jam nut.
7. Secure steering cylinder to RH drag link with washer (item 14) and slotted hex nut (item 13). Install cotter pin (item 12).

8. Remove caps and plugs from hydraulic hoses and fittings.
9. Lubricate and install new O-rings on steering cylinder fittings. Correctly connect hydraulic hoses to steering cylinder fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
10. Check oil level in hydraulic reservoir and add correct oil if necessary.
11. Lubricate cylinder ball joint grease fittings.
12. Follow Hydraulic System Start-up procedures (see Hydraulic System Start-up in this section).
13. Check that steering cylinder does not contact the axle or frame as cylinder moves from fully retracted to fully extended. Also, check that distance between the drag links and steering stops are equal on both sides of the machine. If necessary, adjust location of ball joint on cylinder shaft.

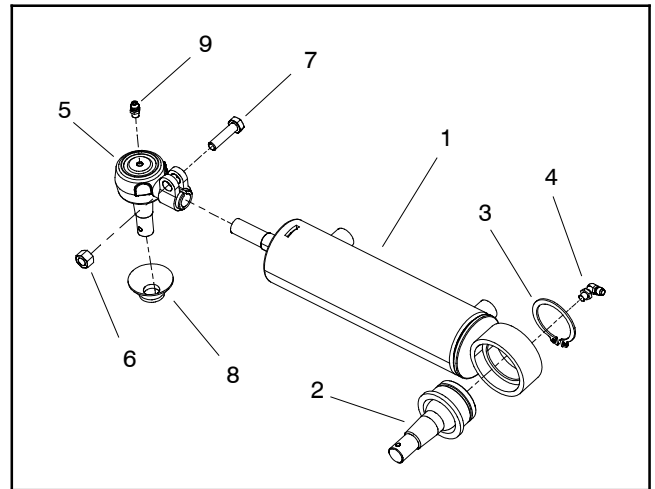


Figure 82

- | | |
|----------------------|-------------------|
| 1. Steering cylinder | 6. Hex nut |
| 2. Ball joint | 7. Cap screw |
| 3. Retaining ring | 8. Seal |
| 4. Grease fitting | 9. Grease fitting |
| 5. Ball joint | |

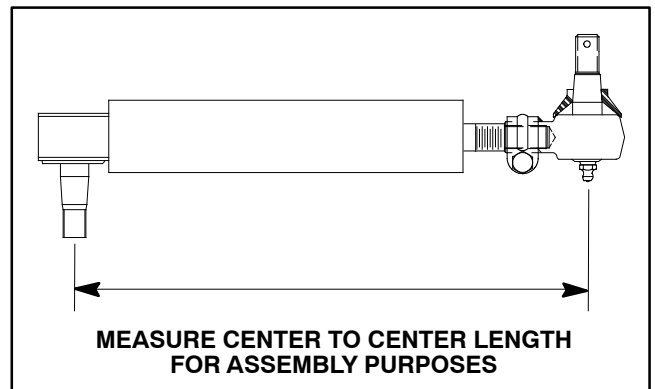


Figure 83

Steering Cylinder Service

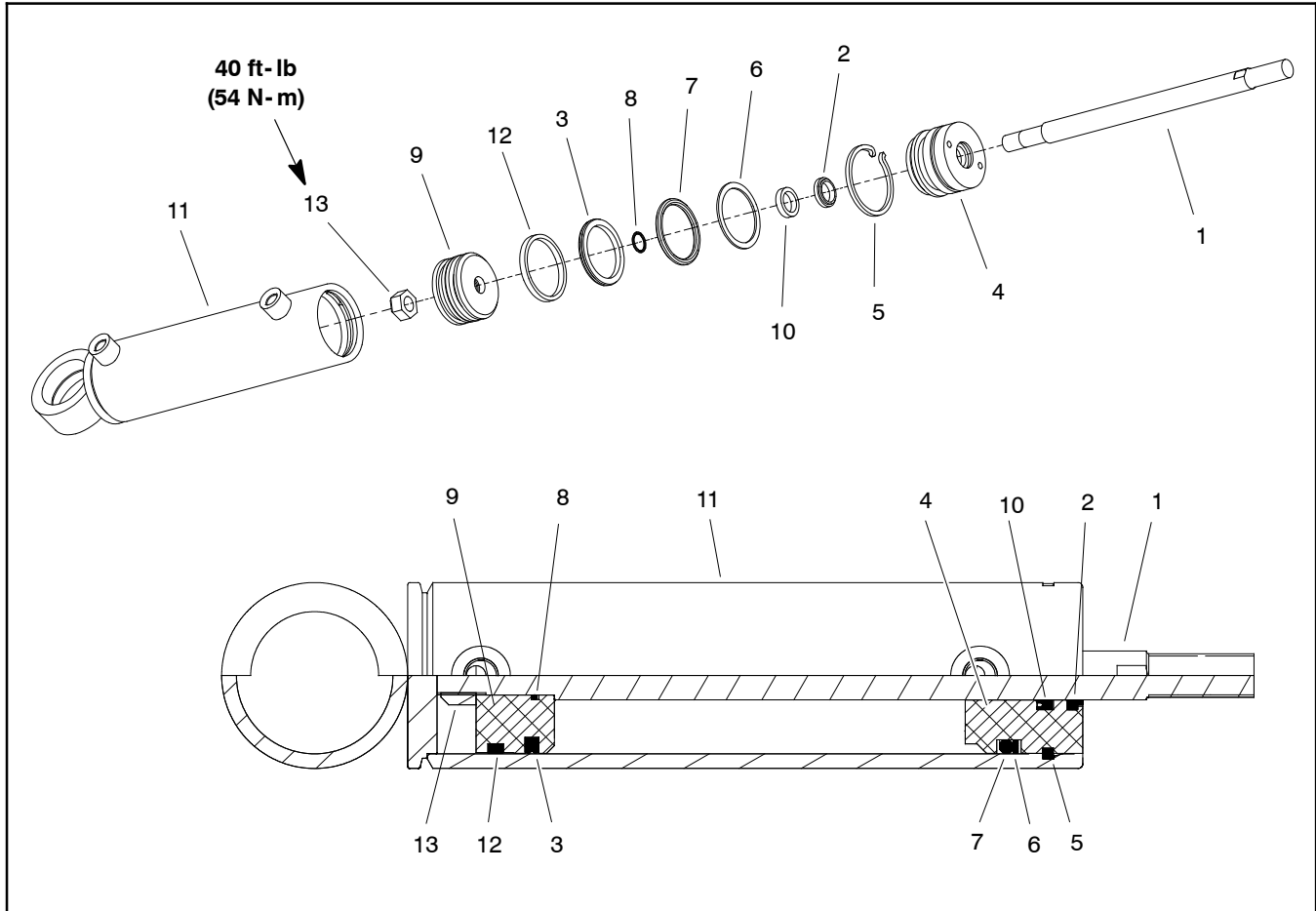


Figure 84

- | | | |
|-------------------|-----------------|---------------|
| 1. Shaft | 6. Back-up ring | 10. BS seal |
| 2. Dust seal | 7. O-ring | 11. Barrel |
| 3. BP seal | 8. O-ring | 12. Wear ring |
| 4. Head | 9. Piston | 13. Lock nut |
| 5. Retaining ring | | |

Disassembly (Fig. 84)

1. Remove oil from steering cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT: Prevent damage when clamping the steering cylinder into a vise; clamp on the clevis end of the barrel ONLY.

2. Mount steering cylinder securely in a vise by clamping on the clevis end of the barrel. Use of a vise with soft jaws is recommended.

3. Using a spanner wrench, rotate head clockwise until the edge of the retaining ring appears in the barrel opening. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening. Rotate the head counter-clockwise to remove retaining ring from barrel and head.

4. Remove plugs from ports. Extract shaft, head and piston by carefully twisting and pulling on the shaft.

IMPORTANT: To prevent shaft damage, do not clamp shaft surface in a vise.

5. Using a wrench on shaft flats to prevent shaft from rotating, remove lock nut.

6. Carefully slide piston and then head from shaft.

7. Taking care to not scratch or damage the piston, remove wear ring, BP seal and O-ring from the piston.

8. Taking care to not scratch or damage the head, remove O-ring, back-up ring, dust seal and BS seal from the head.

9. Discard removed seals and O-rings.

Inspection



1. Wash all cylinder components in solvent. Dry parts with compressed air.
2. Inspect internal surface of barrel for deep scratches, out-of-roundness and bending. Replace if worn or damaged.
3. Inspect head, shaft and piston for excessive pitting, scoring and wear. Replace any worn or damaged parts.

Assembly (Fig. 84)

1. Make sure all cylinder parts are clean before assembly.
2. Coat new O-rings, back-up ring and other seals with clean hydraulic oil.
 - A. Carefully install O-ring, BP seal and wear ring to the piston.
 - B. Carefully install back-up ring, O-ring, BS seal and dust seal to the head.
3. Coat shaft with clean hydraulic oil. Slide head and piston onto the shaft.

IMPORTANT: To prevent shaft damage, do not clamp shaft surface in a vise.

4. Using a wrench on shaft flats to prevent shaft from rotating, install lock nut. Torque lock nut **40 ft-lb (54 N-m)**.

IMPORTANT: Prevent damage when clamping the steering cylinder into a vise; clamp on the clevis end of the barrel **ONLY**.

5. Mount barrel securely in a vise by clamping on the clevis end of the barrel.

IMPORTANT: When installing the head into the barrel, pay careful attention to the retaining ring slot in the barrel to insure that the piston and head seals do not lodge in the slot.

6. Coat all internal parts with a light coat of clean hydraulic oil. Slide piston, shaft and head assembly into the barrel being careful not to damage the seals.

7. Secure head in barrel by installing retaining ring.

- A. Align retaining ring hole in the head with the access slot in the barrel.

- B. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.

Hydraulic Oil Cooler

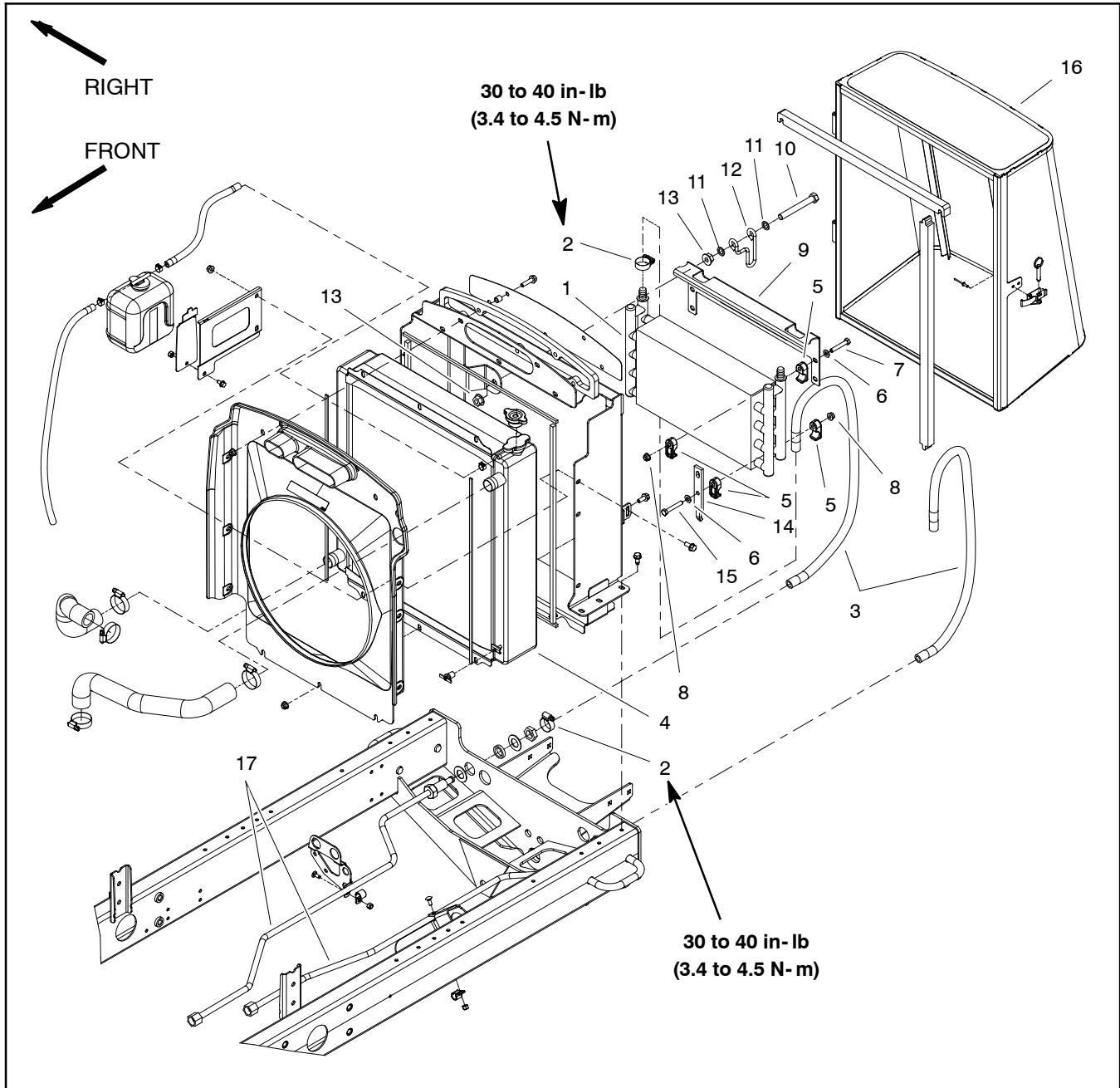


Figure 85

- | | | |
|----------------------------|-------------------------|---------------------------------|
| 1. Oil cooler | 7. Cap screw (4 used) | 13. Flange nut (4 used) |
| 2. Hose clamp (4 used) | 8. Flange nut (10 used) | 14. Cooler mount plate (2 used) |
| 3. Hydraulic hose (2 used) | 9. Top cooler bracket | 15. Cap screw (4 used) |
| 4. Radiator | 10. Cap screw (2 used) | 16. Rear screen |
| 5. Cooler clamp (16 used) | 11. Washer (4 used) | 17. Hydraulic tube (2 used) |
| 6. Flat washer (8 used) | 12. Clamp (2 used) | |

Removal (Fig. 85)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.
2. Unlatch and open the rear screen.
3. Remove battery to ease oil cooler removal (see 12 Volt Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).
4. Label all oil cooler hydraulic connections for assembly purposes. Thoroughly clean hydraulic connections prior to loosening hydraulic hoses at oil cooler.
5. Loosen hose clamps that secure hydraulic hoses to oil cooler fittings. Remove hoses from oil cooler. Allow hoses to drain into a suitable container.
6. Rotate clamps that secure oil cooler to radiator frame.
7. Carefully remove oil cooler from machine.
8. If necessary, remove clamps and brackets from oil cooler using Figure 85 as a guide.

Inspection

1. Back flush oil cooler with cleaning solvent. After cooler is clean, make sure all solvent is drained from the cooler.



CAUTION

Use eye protection such as goggles when using compressed air to clean the oil cooler.

2. Dry inside of oil cooler using compressed air in the opposite direction of oil flow.
3. Plug both ends of oil cooler. Clean exterior of cooler. Make sure oil cooler fins are clear of dirt and debris.
4. The oil cooler should be free of corrosion, cracked tubes or excessive pitting of tubes.

Installation (Fig. 85)

1. If removed, install clamps and brackets to oil cooler using Figure 85 as a guide.
2. Position oil cooler to radiator and secure with clamps.
3. Install hydraulic hoses to oil cooler fittings and secure with hose clamps.
4. Install battery (see 12 Volt Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).
5. Close and secure rear screen.
6. Check oil level in hydraulic reservoir and add correct oil if necessary.

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Electrical System

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Electrical System

General Information


Operator's Manual

The Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Reelmaster machine. Refer to that publication for additional information when servicing the machine.

Electrical Drawings

The electrical schematic and wire harness drawings for Reelmaster 5010- H machines are located in Chapter 9 - Foldout Drawings.

48 VDC Battery Disconnect

**CAUTION**

Before installing, removing or servicing components in the 48 VDC system (e.g. cutting unit motors, motor/generator), separate the 48 VDC battery disconnect. This will prevent unexpected operation of 48 VDC system components.

The 48 VDC battery disconnect is attached to the right frame rail under the operator seat (Fig. 1). Unplug the disconnect to make sure that 48 VDC components do not operate unexpectedly. Apply dielectric grease to the contact surfaces of the battery disconnect and plug the battery disconnect back in after service to the 48 VDC system is completed.

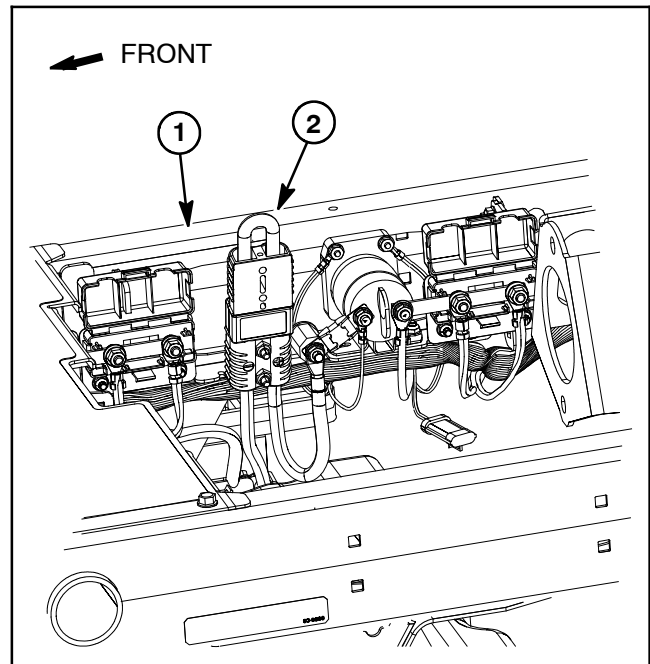


Figure 1

- 1. RH frame rail
- 2. 48V battery disconnect

Toro Electronic Controller (TEC)

Reelmaster 5010- H machines use a Toro Electronic Controller (TEC) to manage machine electrical functions. The controller is microprocessor controlled that senses the condition of various switches and sensors (inputs). The controller then directs electrical power to control appropriate machine functions (outputs) based on the input state. Communication between the TEC controller, the InfoCenter Display, the cutting unit motors and the motor/generator is provided by a CAN- bus system. The status of inputs to the TEC controller as well as outputs from the TEC controller can be monitored with the InfoCenter Display.

The TEC controller is located behind the access panel on the outside of the control arm (Fig. 2).

IMPORTANT: To prevent machine electrical system damage while welding on the machine, disconnect the battery cables from the batteries, disconnect the wire harness connectors from the Toro Electronic Controller and disconnect the terminal connector from the alternator.



Figure 2

1. Control arm
2. TEC controller

CAN-bus Communications

System communication between electrical components on Reelmaster 5010- H machines is accomplished on two (2) CAN-bus communication systems. These CAN-bus systems reduce the number of electrical components and connections used on the machine and allow the number of wires in the wire harness to be reduced. The integration of machine electrical functions also allows the InfoCenter Display to assist with electrical system diagnostics.

One of these CAN-bus systems allows TEC controller communication between machine 12 VDC components (e.g. engine components, InfoCenter display). The second CAN-bus system provides necessary control for the electric cutting reels system (motor/generator, cutting reel motors). An isolation module is included in the machine electrical system to allow communication between the two systems while maintaining ground isolation for the 48 VDC system.

CAN identifies the Controller Area Networks that is used on the Reelmaster. Two (2) specially designed, twisted wires form the bus for both of the networks used on the Hybrid machines. These wires provide the data pathways between machine components. The engineering term for these two (2) wires are CAN-high and CAN-low. At the ends of the twisted pair of bus wires are 120 ohm termination resistors. The bus wires for the 12 VDC circuits are black/white and red/white and the bus wires for the 48 VDC circuits are green and yellow.

Each of the components that is controlled by the CAN-bus link needs only four (4) wires to operate and communicate to the system: CAN High, CAN Low, B+ (power) and ground. The CAN-bus needs the ignition switch ON input for the TEC, InfoCenter Display, motor/generator and cutting unit motors to be activated.

IMPORTANT: The termination resistors at the ends of the bus wires are required for proper electrical system operation.

Electrical System Operation

Reelmaster 5010-H machines use two (2) separate electrical systems. Most machine functions operate on a typical 12 VDC system. The second system exists to operate the electric cutting reels and is a 48 VDC electrical system. Basic information about the two systems is included below.

12 VDC System Operation

Engine electrical components, machine operation switches, hydraulic solenoid coils, the machine Toro electronic controller (TEC) and the InfoCenter display are all included in the 12 VDC system on Reelmaster 5010-H machines. A 12 volt battery at the rear of the machine and the engine alternator provide system electrical power. Circuit protection for the 12 VDC system includes two (2) fuse blocks, an inline TEC logic fuse and several fusible links.

12 VDC system communication between the TEC controller, InfoCenter display and the motor/generator is accomplished on a CAN-bus communication system. Two (2) specially designed, twisted wires form the bus for this network. The bus wires for the 12 VDC circuits are black/white and red/white.

Information about electrical components in the 12 VDC system is included in the Component Testing and Service and Repairs sections of this chapter.

48 VDC System Operation

The Reelmaster 5010- H 48 VDC system includes a 48 VDC battery pack, an engine driven motor/generator assembly, five (5) cutting reel motors, a main contactor used to energize the system and additional circuit control components. Circuit protection for the 48 VDC system includes five (5) fuses in a single fuse block, an inline system logic fuse and a system Maxi-fuse.

The battery pack is composed of four (4) 12 VDC sealed batteries connected in series to achieve the necessary 48 VDC system voltage. The batteries are absorbed glass mat (AGM), valve regulated lead acid batteries that are maintenance free.

IMPORTANT: When connecting the battery pack in the 48 VDC system, make sure that battery polarity is carefully checked. System damage can occur if batteries are not connected correctly.

The motor/generator is a 48 VDC, air cooled, brushless, permanent magnet device. The motor/generator has its own integral inverter and on-board controller. The InfoCenter Display can be used to monitor motor/generator activity during machine operation.

The five (5) cutting reel motors are identical 48 VDC, brushless, permanent magnet motors. Each motor has its own integral inverter and on-board controller. The InfoCenter Display can be used to monitor the speed and current draw for the five (5) cutting unit motors during machine operation.

The main contactor exists in the 48 VDC system to connect the 48 VDC battery pack with the motor/generator and reel motor controllers. The motor/generator controller determines when the main contactor is engaged.

Control for the components in the 48 VDC system is handled by integral controllers in the motor/generator and reel motors along with direction from the machine TEC controller via the CAN-bus system. Since the TEC controller (12 VDC component) sends and receives information with the motor/generator and reel motors (48 VDC components), the CAN-bus circuit needs to communicate with both systems. The isolation module is included in the system to allow effective machine communication while keeping the two electrical systems isolated. Also, the location ID module exists to identify the location of the five (5) cutting reel motors. This allows such machine features as starting the rear cutting units slightly later than the front cutting units.

The 48 VDC system is an isolated system so the vehicle frame is not used for any ground connections in this system. A 48 VDC battery disconnect is included on the machine which should be used to disconnect 48 VDC system components from the electrical power supply to prevent unexpected component operation when performing service.

Information about electrical components in the 48 VDC system is included in the Component Testing and Service and Repairs sections of this chapter.

PowerMatch™ System

The PowerMatch™ system allows the Reelmaster 5010- H to control 48 VDC motor/generator operation so that changing load conditions can be handled by the machine automatically.

In typical, lighter load conditions (e.g. mowing on flat ground), engine output provides sufficient power to drive the motor/generator and hydraulic pump package. In this situation, the motor/generator keeps the 48 VDC battery pack fully charged and the cutting reel motors operational.

In moderate load conditions (e.g. mowing on intermediate slopes), the motor/generator transfers some or all of its load from the engine. In these conditions, the cutting reel motors can be driven exclusively by the battery pack if needed. With the motor/generator load reduced or possibly inactive, the engine maintains hydraulic traction performance while the battery pack assists in keeping the reels running at the proper set speed.

If load conditions demand maximum performance (e.g. mowing on severe inclines), the battery pack can be used to power both the cutting unit motors and the motor/generator. The battery powered motor/generator assists the engine in maintaining traction performance and the battery pack keeps the reels running at the proper set speed.

Special Tools

Order Special Tools from your Toro Distributor.

Digital Multimeter

The multimeter can test electrical components and circuits for current, resistance or voltage. Obtain this tool locally.

NOTE: Toro recommends the use of a DIGITAL Volt-Ohm-Amp multimeter when testing electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode will make sure that excess current is not allowed through the meter. This excess current could cause damage to circuits not designed to carry it.

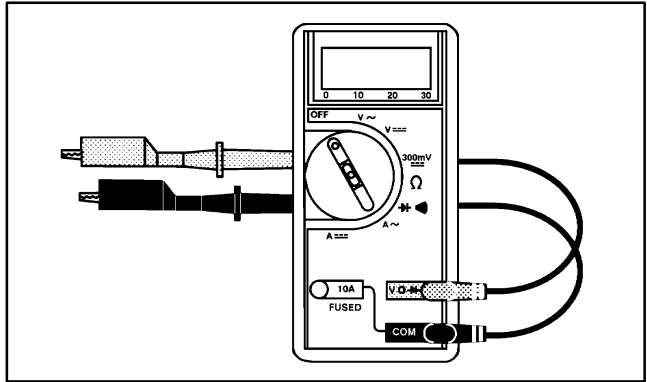


Figure 3

Battery Terminal Protector

Toro Part Number: **107-0392**

Aerosol spray that should be used on battery terminals, ring terminals and fork terminals to reduce corrosion problems. Apply terminal protector to the connection after the battery cable, ring terminal or fork terminal has been secured.



Figure 4

Dielectric Gel

Toro Part Number: **107-0342**

Dielectric gel should be used to prevent corrosion of unsealed connection terminals. To ensure complete coating of terminals, liberally apply gel to both component and wire harness connector, plug connector to component, unplug connector, reapply gel to both surfaces and reconnect harness connector to component. Connectors should be thoroughly packed with gel for effective results.

Do not use dielectric gel on sealed connection terminals as the gel can unseat connector seals during assembly.



Figure 5

Cutting Reel Motor Rotor Tool Set

Toro Part Number: **127-2574** (for both 5" and 7" cutting unit motors)

The rotor tool set for the cutting reel motor is required to remove and install the rotor from the reel motor housing. Tool set includes puller hub, threaded shaft, handle and four (4) screws (Fig. 6).

NOTE: Toro part number TOR6028 can be used to service cutting unit motors on 5" cutting units and is also used on other Toro products. TOR6028 will not work on 7" cutting unit motors.

NOTE: For cutting reel motor service procedures, see Cutting Reel Motor Service in the Service and Repairs section of this chapter.

IMPORTANT: When working on the cutting reel motor, use a clean work space with a non-metal surface. The cutting reel rotor includes very powerful magnets.

Cutting Reel Motor Rotor Removal

1. Remove gearbox cover and output gear from motor assembly (see Cutting Reel Motor Service in the Service and Repairs section of this chapter).
2. Remove screws that secure motor cover. Do not remove cover from motor assembly because it will be removed with reel motor rotor during rotor removal.
3. Secure tool set base plate to motor housing with four (4) of the cover screws.
4. Install threaded shaft into base plate.

IMPORTANT: The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during removal. Be cautious during rotor removal to prevent component damage or personal injury.

5. Turn threaded shaft with handle to remove rotor and motor cover from motor housing. Support rotor to prevent it from falling from housing during removal.
6. Leave threaded shaft installed in same position in base plate for rotor installation purposes.

Cutting Reel Motor Rotor Installation

1. Secure tool set base plate to motor housing with four (4) of the cover screws.

2. Make sure that threaded shaft is installed into base plate so that the end of the threaded shaft prevents the rotor body from entering the motor housing.

IMPORTANT: The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during installation. Be cautious during rotor installation to prevent component damage or personal injury.

3. While guiding rotor into motor housing, slowly rotate threaded shaft to allow the rotor to be drawn into the housing. Once rotor is fully installed into housing, remove tool set from motor housing.

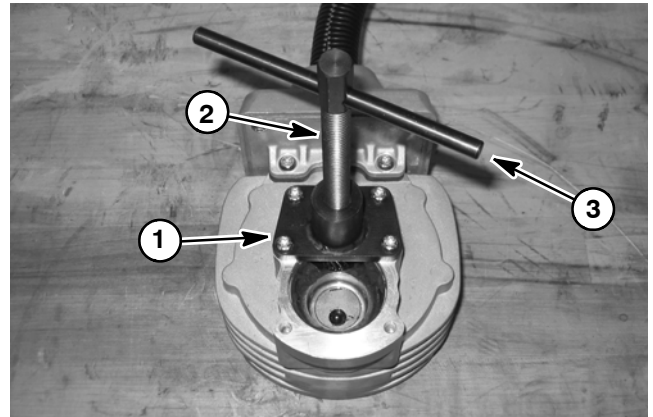


Figure 6

1. Puller hub
2. Threaded shaft
3. Handle

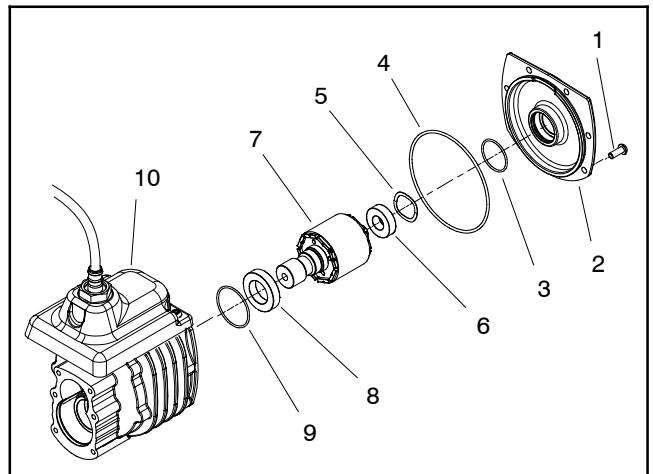


Figure 7

1. Screw (6 used)
2. Motor cover
3. O-ring
4. O-ring
5. Wave washer
6. Bearing
7. Rotor
8. Bearing
9. O-ring
10. Housing assembly

Generator Rotor Tool Set

Toro Part Number: TOR6029

The generator rotor tool set is required to remove and install the rotor from the motor/generator housing. Tool set includes base plate, threaded shaft and handle (Fig. 8).

NOTE: For motor/generator service procedures, see Motor/Generator Assembly Service in the Service and Repairs section of this chapter.

IMPORTANT: When working on the motor/generator, use a clean work space with a non-metal surface. The motor/generator rotor includes very powerful magnets.

Motor/Generator Rotor Removal (Fig. 9)

1. Remove screws that secure motor/generator cover. Do not remove cover from motor/generator assembly because it will be removed with motor/generator rotor during rotor removal.

2. Secure tool set base plate to motor/generator housing with three (3) 3/8" - 16 X 3" cap screws.

IMPORTANT: To prevent damage to motor/generator rotor shaft threads, position a thick washer or spacer on end of the rotor shaft when using tool set.

3. Position thick washer or spacer on the end of the motor/generator rotor shaft. Install threaded shaft into base plate and against washer or spacer on rotor shaft.

IMPORTANT: The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during removal. Be cautious during rotor removal to prevent component damage or personal injury.

4. Turn threaded shaft with handle to remove motor/generator rotor and cover from motor/generator housing. Support rotor to prevent it from falling during removal.

5. Leave threaded shaft installed in same position in tool base plate for rotor installation purposes.

Motor/Generator Rotor Installation (Fig. 9)

1. Secure tool set base plate to motor/generator housing with three (3) 3/8" - 16 X 3" cap screws.

2. Make sure that threaded shaft is installed into tool base plate so that the end of the threaded shaft prevents rotor body from entering the motor/generator housing.

IMPORTANT: The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during installation. Be cautious during rotor installation to prevent component damage or personal injury.

3. While guiding rotor into motor/generator housing, slowly rotate threaded shaft to allow the rotor to be drawn into the housing. Once rotor is fully installed into housing, remove special tool set from motor/generator housing.

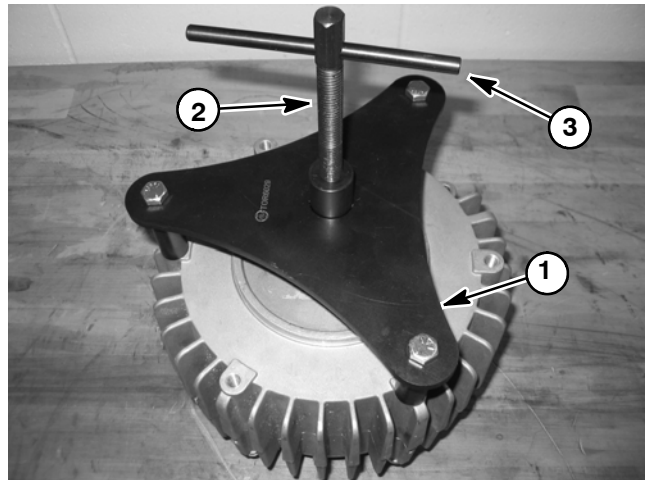


Figure 8

- 1. Base plate
- 2. Threaded shaft
- 3. Handle

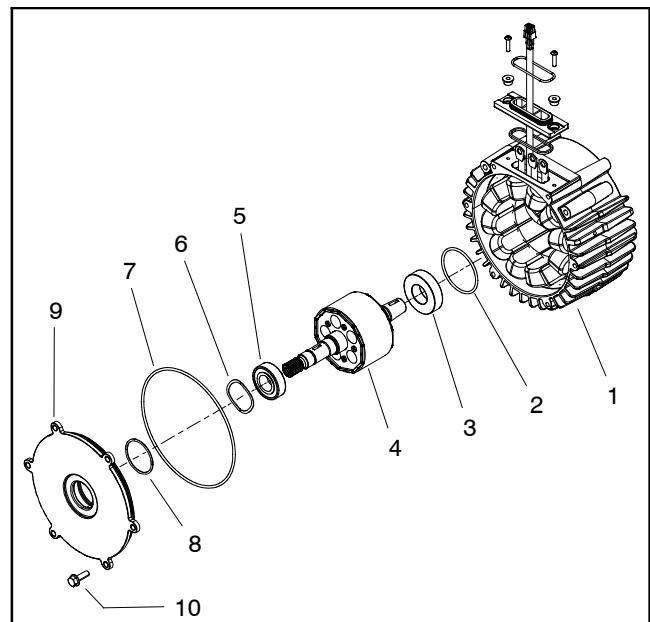


Figure 9

- 1. Housing/stator assembly
- 2. Wave washer
- 3. O-ring
- 4. Rotor assembly
- 5. Bearing
- 6. Wave washer
- 7. O-ring
- 8. O-ring
- 9. Cover
- 10. Flange screw (6 used)

Battery Hydrometer

Use the battery hydrometer when measuring specific gravity of battery electrolyte in the machine 12 VDC battery. Obtain this tool locally.

NOTE: A battery hydrometer is not usable for the batteries in the Reelmaster 5010-H 48 VDC battery system. These batteries are valve regulated, sealed lead acid batteries that are maintenance free with no provision for checking or adjusting electrolyte level.



Figure 10

Plastic Plug

Toro Part Number: **2410-30** (for 5 inch reels)
94-2703 (for 7 inch reels)

This cap is used for placement into the cutting unit side plate when the cutting reel motor is removed. It prevents dirt and debris from entering the cutting reel bearing area.

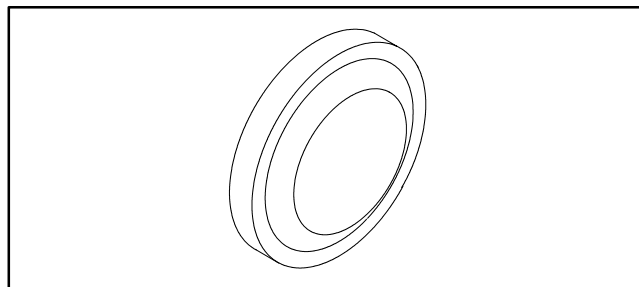


Figure 11

InfoCenter Display

The InfoCenter Display used on your Reelmaster is a LCD device that is located on the console. The InfoCenter provides information for the machine operator during machine operation, provides electrical system diagnostic assistance for technicians and allows inputs for adjustable machine settings.

Power for the InfoCenter is available when energized by the main power relay (ignition switch in the ON/PREHEAT or START position). CAN- bus systems involving the machine TEC controller, the InfoCenter, the motor/generator and the cutting unit motors are used to provide necessary machine communication for InfoCenter operation.

NOTE: Icons that are used on the InfoCenter display are identified in the Traction Unit Operator's Manual.

Splash Screen

The InfoCenter splash screen (Fig. 12) is displayed when the ignition switch is initially turned to the ON/PREHEAT or START position. The splash screens allow basic machine information to be reviewed by the operator. After the splash screens has been on the InfoCenter for several seconds, the main information screen will be displayed on the InfoCenter.

The splash screen can be used to identify machine 12 VDC battery voltage, hourmeter reading, fuel tank level and whether the glow plugs are energized.

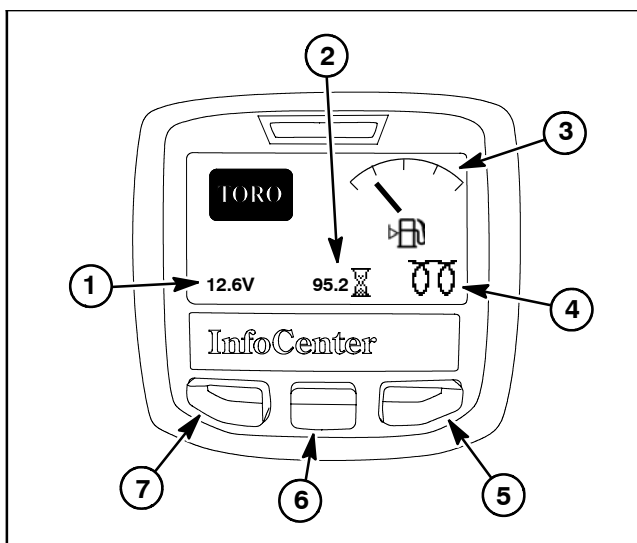


Figure 12

- | | |
|---------------------------|---------------------|
| 1. 12 VDC battery voltage | 5. Right button |
| 2. Hour meter | 6. Middle button |
| 3. Fuel gauge | 7. Menu/back button |
| 4. Glow plugs energized | |

Main Information Screens

The two (2) InfoCenter main information screens (Figs. 13 and 14) are displayed after the initial splash screen has been displayed for several seconds. During normal machine operation, the main information screens provide machine information for the operator. Toggling between the main information screens is done by pressing the right button on the InfoCenter.

The main information screens can be used to monitor engine coolant temperature, fuel tank level, 48 VDC battery voltage, engine RPM, motor/generator temperature and traction speed range. The screens will also identify if the parking brake is applied or if the cutting decks are engaged.

The main information screens will also display arrows whenever the cutting deck sections are either raising (up arrows) or lowering (down arrows).

If controls are not selected properly to allow certain machine operations, the InfoCenter indicator light will illuminate and an advisory will be displayed on the InfoCenter Display (see Advisories in the Troubleshooting section of this chapter). Typically, an advisory can be eliminated with a change in controls by the operator.

If an electrical machine fault occurs during machine operation, the InfoCenter indicator light will blink to notify the operator. Accessing the fault log is described below in Faults Screen.

The main menu and additional information screens can be accessed from the InfoCenter main information screen by pressing and releasing the menu/back button (left button) on the display. Information on the main menu and menu item screens is included below.

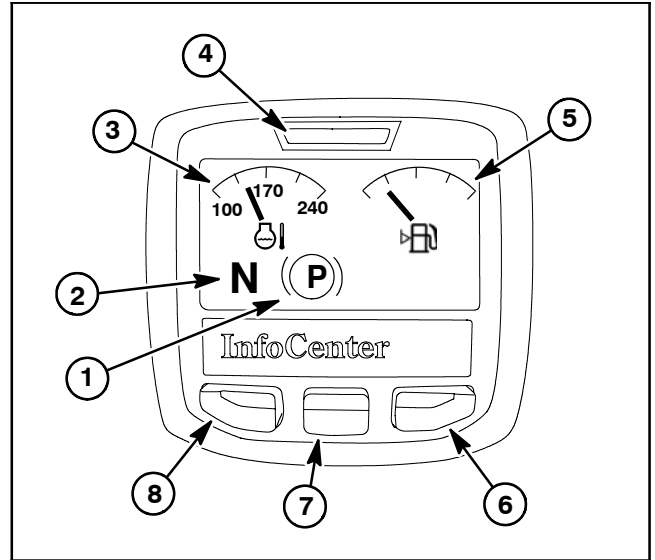


Figure 13

- | | |
|--------------------------|---------------------|
| 1. Parking brake applied | 5. Fuel gauge |
| 2. Traction speed range | 6. Right button |
| 3. Coolant temperature | 7. Middle button |
| 4. Indicator light | 8. Menu/back button |

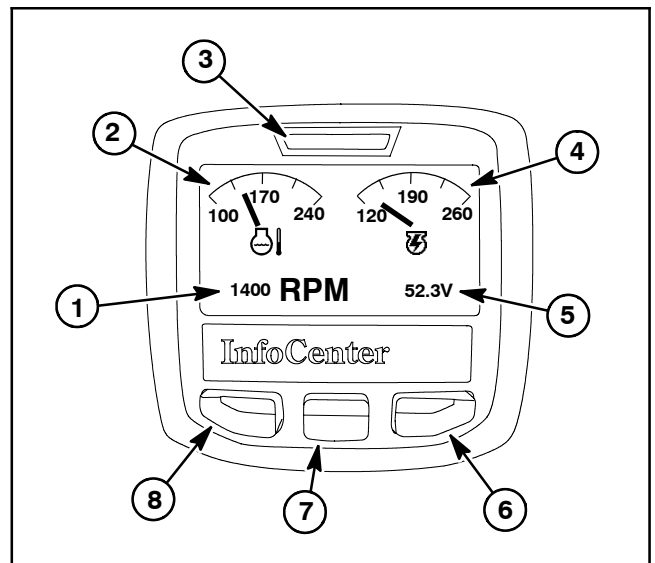


Figure 14

- | | |
|--------------------------|---------------------------|
| 1. Engine RPM | 5. 48 VDC battery voltage |
| 2. Coolant temperature | 6. Right button |
| 3. Indicator light | 7. Middle button |
| 4. Generator temperature | 8. Menu/back button |

Access Protected Display Screens

The protected display screens are available on the InfoCenter to view the electrical status of the 48 VDC power circuit. The protected display screens can be viewed after the Protected Menus are available by entering the machine PIN (see Settings Screen in this section). Toggling between the protected display screens is done by pressing the middle button on the InfoCenter when they are active.

The **eReel Info** screen (Fig. 15) displays the speed and current draw for the five (5) individual cutting unit motors.

In typical, lighter load conditions (e.g. mowing on flat ground), engine output provides sufficient power to drive the motor/generator and hydraulic pump package. In this situation, the motor/generator keeps the 48 VDC battery pack fully charged and the cutting reel motors operational (Fig. 16).

In moderate load conditions (e.g. mowing on intermediate slopes), the 48 VDC battery system can be used to power the cutting reel motors and the motor/generator load is reduced or removed from the engine. With the motor/generator inactive, the engine maintains traction performance while the batteries keep the reels running at the set speed.

If load conditions demand maximum machine performance (e.g. mowing on severe inclines), the battery pack can be used to power both the cutting unit motors and the motor/generator (Fig. 17). The battery powered motor/generator assists the engine in maintaining traction performance and the battery pack keeps the reels running at the proper set speed.

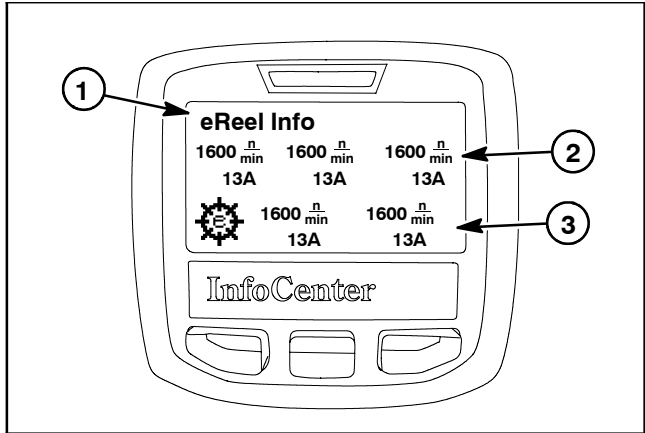


Figure 15

1. Reel information screen
2. Front motors
3. Rear motors

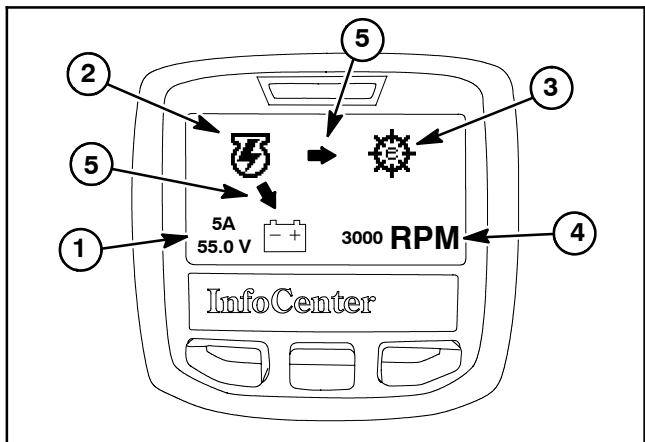


Figure 16

1. 48V battery pack status
2. Motor/generator
3. Reel motor circuit
4. Engine RPM
5. Energy flow

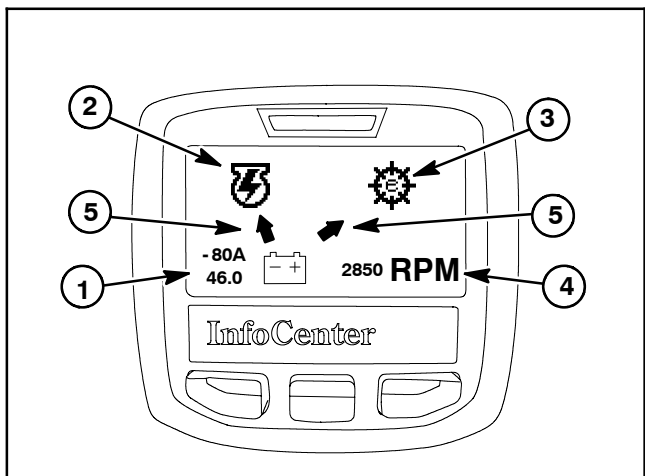


Figure 17

1. 48V battery pack status
2. Motor/generator
3. Reel motor circuit
4. Engine RPM
5. Energy flow

Main Menu Screen

The main menu screen can be accessed from the InfoCenter main information by pressing and releasing the menu/back button (left button) on the display twice. Once at the main menu screen (Fig. 18), navigation to the five (5) different menu items can occur. Pressing the move to menu item button (middle button) allows a different menu item to be highlighted. Selection of the highlighted item is completed by pressing the choose menu item button (right button).

The main menu items include faults, service, diagnostics, settings and about. These menu items are described below.

To return to the main information screen from the main menu screen, press the back button (left button).

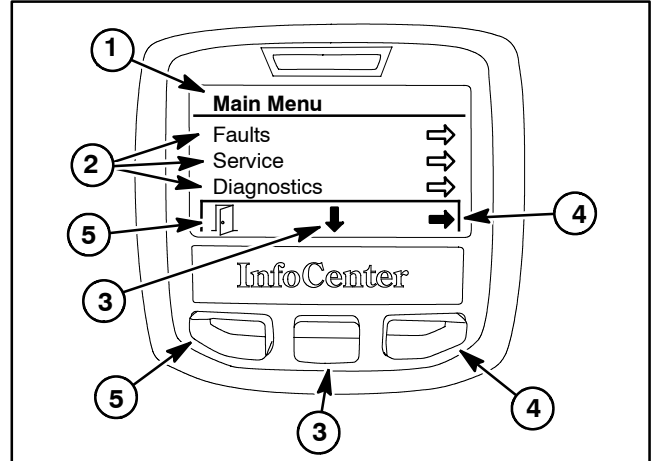


Figure 18

1. Main menu
2. Menu items
3. Move to menu items
4. Choose menu item
5. Back button

Faults Screen

The faults screen (Fig. 19) will list all machine electrical faults that have occurred since the faults were last cleared from the InfoCenter. The faults will be identified by a fault number and when the fault occurred. Faults that might occur on the machine are listed in Fault Codes in the Troubleshooting section of this chapter.

After entry of the PIN code (see Protected Menus in the Settings Screen of this section), the InfoCenter fault log can be cleared by selecting the clear system faults menu item in the faults screen. The cleared faults will be removed from the InfoCenter list but will be retained in the TEC controller memory.

If a fault occurs during machine use, there may be a change in machine functionality due to the fault. Should there be machine operation issues due to a fault, a first step to remedy the issue would be to disengage the cutting units, release the traction pedal, wait for the machine to stop moving, turn the ignition switch OFF and allow all machine functions to stop. Then, attempt to restart the machine to see if operation has returned to normal. Some faults will be reset during the restart and will then allow normal function. If a fault continues to occur, further system evaluation and possible component repair or replacement will be necessary.

To return to the main menu screen from the faults screen, press the back button (left button).

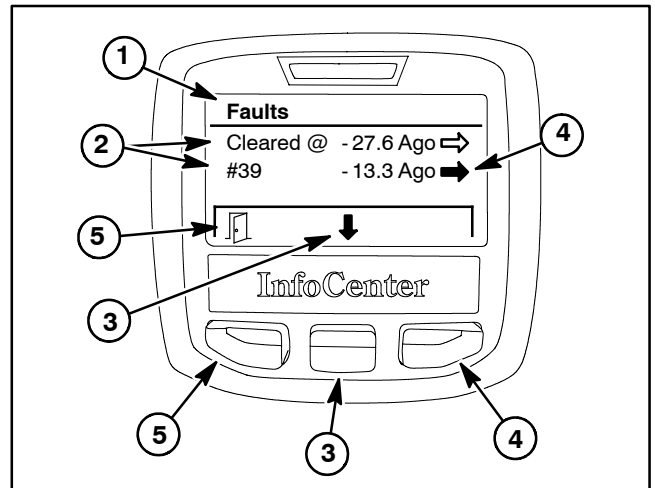


Figure 19

1. Fault menu
2. Fault items
3. Move to menu items
4. Choose menu item
5. Back button

Service Screen

The service screen (Fig. 20) contains machine operational information including hours, counts, reset defaults and cutting unit backlap engage. Values listed for these service menu items cannot be changed. If the machine PIN has been entered to allow access to protected menu items in the settings screen, the protected service menu items will be listed and available in the service screen.

NOTE: If the protected menu items are available, PIN will be shown in the upper right corner of the InfoCenter display.

The options listed for **hours** include the following:

- **Key On** identifies the number of hours that the ignition switch has been in the ON/PREHEAT position.
- **Machine Run** identifies the number of hours that the engine has been running.
- **PTO On** identifies the number of hours that the machine has been operated with the cutting units engaged.
- **Front Cutting Units in Backlap** identifies the number of hours that the front cutting units have been operated in the backlap position.
- **Rear Cutting Units in Backlap** identifies the number of hours that the rear cutting units have been operated in the backlap position.
- **Transport Speed** identifies the number of hours that the machine has been operated in transport speed.

- **Service Due** identifies the number of hours before the next scheduled maintenance is due. The service due hours listed on the InfoCenter will decrease as the machine is used. The service due hours can be reset after maintenance is performed.

The options listed for **counts** include the following:

- **Starts** identifies the number of times that the engine has been started.
- **PTO** identifies the number of times that the engage/disengage switch has been engaged.
- **Front Cutting Units in Backlap** identifies the number of times that the front cutting units have been operated in the backlap position.
- **Rear Cutting Units in Backlap** identifies the number of times that the rear cutting units have been operated in the backlap position.
- **Engine Coolant Caution** identifies the number of times that engine coolant temperature was elevated.

- **Engine Coolant Excessive** identifies the number of times that excessive engine coolant temperature caused the engine to stop.

- **Battery kW-H** identifies the total electrical energy (in kilowatt hours) that has been provided by the 48 VDC battery pack. The battery kW-H listed on the InfoCenter will increase as the machine is used. The battery kW-H can be reset when needed (e.g. battery pack is replaced).

The **reset defaults** service screen option allows machine settings to be returned to factory defaults.

The **front cutting units backlap** service screen option allows the front cutting units to be placed in backlap.

The **rear cutting units backlap** service screen option allows the rear cutting units to be placed in backlap.

IMPORTANT: If the backlap function is not returned to the OFF setting after backlapping, the cutting units will not raise or function properly.

To reset the service due hours or battery kW-H count, access the protected menu so that PIN is shown on InfoCenter display. The protected menu items for resetting the service due hours and battery kW-H count will be available on the InfoCenter.

To return to the main menu screen from the service screen, press the back button (left button).

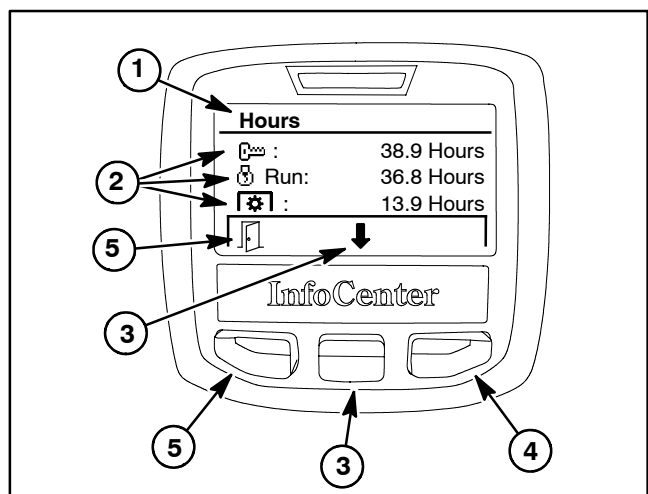


Figure 20

1. Service menu
2. Service items
3. Move to menu items
4. Choose menu item
5. Back button

Diagnostics Screen

The diagnostics screen (Fig. 21) lists the various states of machine electrical components. The diagnostics screen should be used to check operation of machine controls and to verify that switches and circuit wiring are functioning correctly.

For each of the diagnostics screen items, inputs, qualifiers and outputs are identified. The diagnostics screen includes the following:

- **Cutting Units** identifies machine requirements to allow the cutting units to raise and lower. Inputs indicate the state of the joystick raise and lower switches and the position of the ignition switch. Qualifiers include whether the engine is running and the seat is occupied, that the traction system is in the LOW range speed and inputs are OK to lower and raise. Identified outputs consist of SV1, SV2, SV3 and SVRV solenoid coils.

- **Hi/Low Range** identifies machine requirements to allow LOW (mow) or HI (transport) speed range to be engaged. Inputs indicate the state of the mow/transport switch. Qualifiers identify the position of the seat switch, whether the cutting units are raised and the position of the engage/disengage (PTO) switch. There are no outputs from the TEC controller for the Hi/Low range function.

- **PTO** identifies machine requirements to allow the cutting units to be engaged. Inputs indicate the state of the PTO (engage/disengage) switch. Qualifiers identify whether LOW speed range is selected, if the engine is running, if the seat is occupied, if the engine temperature is not excessive and if the cutting units are lowered. Outputs indicate that the rear cutting units and/or the front cutting units are engaged.

- **Engine Start** identifies whether necessary TEC outputs exist to allow the engine to start and run. Inputs indicate the state of the ignition switch (ON and START). Qualifiers identify whether the joystick is in the neutral position (neither lower nor raise engaged), that the PTO (engage/disengage) switch is OFF, if the traction pedal is in neutral and if the seat is occupied or parking brake is applied. Outputs indicate that the fuel actuator is energized and, when the ignition switch is in the START position, that the start output is energized.

- **Backlap** identifies machine requirements to allow the cutting unit backlap process to be engaged. Inputs indicate the state of the backlap settings (ON or OFF from Service menu screen) and the PTO status (ON or OFF). Qualifiers identify that the parking brake is applied, the mow/transport lever is in the MOW position, the cutting units are lowered and that the engine is running. Outputs indicate whether the front and/or the rear cutting units are in the backlap mode.

To return to the main menu screen from the diagnostics screen, press the back button (left button).

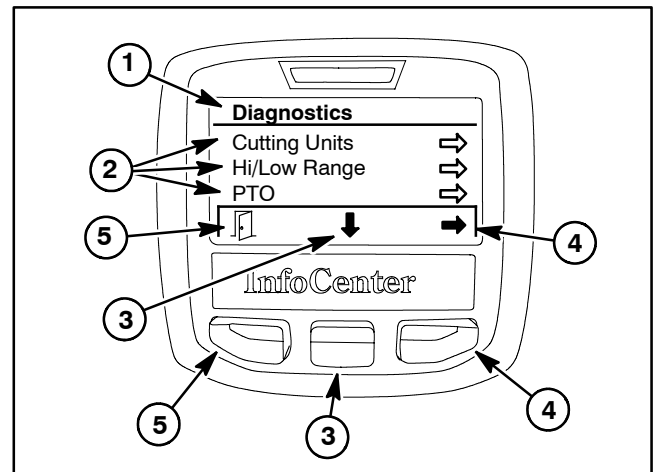


Figure 21

- | | |
|-----------------------|---------------------|
| 1. Diagnostics menu | 4. Choose menu item |
| 2. Diagnostics items | 5. Back button |
| 3. Move to menu items | |

Settings Screen

The settings screen identifies the InfoCenter **units** (English or Metric) and **language**. The settings screen also allows the operator to customize the **backlight** (brightness) and **contrast** settings for the InfoCenter display.

If either the backlight (brightness) or contrast items are selected, the middle button (-) or right button (+) can be used to change the display settings.

The settings screen includes the current setting for **backlapping speed** (B'lap RPM) for the front (F) and rear (R) cutting units. Backlapping speed can be adjusted by selecting either the front or rear cutting units and using the right button on the InfoCenter to modify the speed.

Protected menus allows the machine PIN to be entered so that hidden machine settings screen items can be viewed and modified. Protected menu items include protect settings, auto idle, blade count, mow speed, height of cut (HOC), front reel RPM, rear reel RPM and economy mode.

To allow access to the protected menu items when protected settings is ON (see Protected settings below), enter the four (4) digit pin PIN using the middle and right InfoCenter buttons. After PIN has been entered, a check mark should be visible above middle InfoCenter button. Press middle button and the InfoCenter display screen should indicate "PIN" in the upper right hand corner if the correct PIN number was entered. The protected menu items should be available in the settings menu and can be changed as long as the ignition switch remains in RUN and "PIN" is displayed on the InfoCenter.

NOTE: The initial PIN will either be 1234 or 0000. If the PIN has been changed and is forgotten, a temporary PIN can be obtained from your Toro distributor.

To change the machine PIN, access the protected menu items by entering the current PIN. The InfoCenter display screen should indicate "PIN" in the upper right hand corner after the current PIN number is entered. Select the protected menu item again and note that "Edit PIN" is indicated on InfoCenter display screen. A new PIN can be entered and then saved.

Protected settings allows the settings for auto idle, blade count, mow speed, height of cut (HOC), front reel RPM, rear reel RPM and economy mode to be hidden so they cannot be changed unless the PIN is entered. If the protect settings is ON, these settings will not be seen when using the InfoCenter until the protected menus is selected and the machine PIN is entered. If protect settings is OFF (default setting), settings for these functions will be visible on the InfoCenter and can be adjusted by the operator at any time.

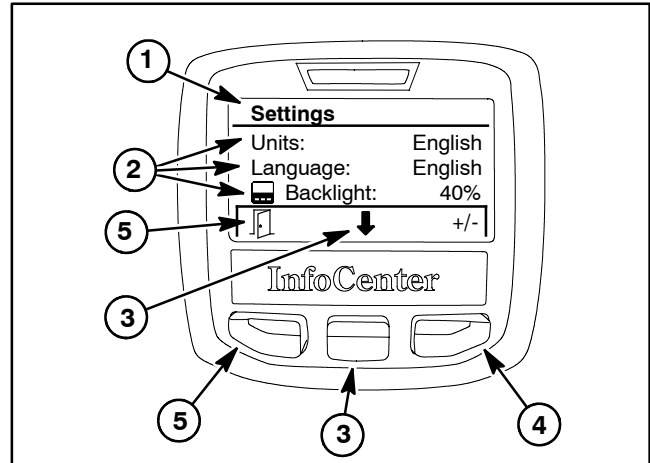


Figure 22

- | | |
|-----------------------|---------------------|
| 1. Settings menu | 4. Change menu item |
| 2. Settings items | 5. Back button |
| 3. Move to menu items | |

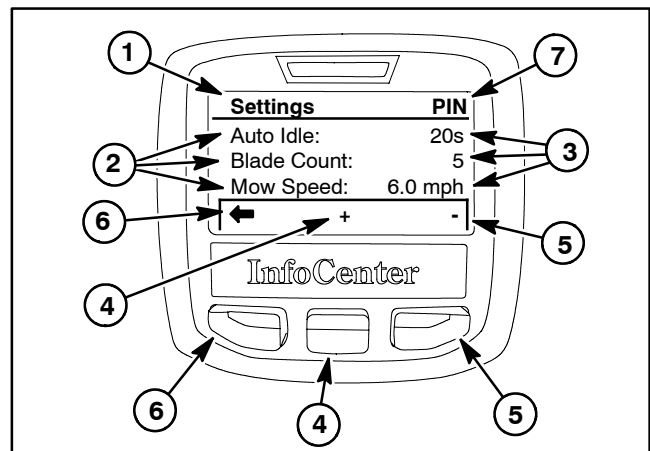


Figure 23

- | | |
|---------------------|---------------------|
| 1. Settings menu | 5. Decrease setting |
| 2. Settings items | 6. Back button |
| 3. Current settings | 7. PIN activated |
| 4. Increase setting | |

Auto Idle causes the engine speed to decrease to low idle after the machine has not been in use for the set time delay in seconds. Auto idle can be adjusted to 8, 10, 15, 20 or 30 seconds or the auto idle feature can be turned OFF. Engine speed automatically returns to the previously set speed when either the traction pedal is moved from neutral or the joystick is moved to either raise or lower.

Blade Count identifies the number of blades on the cutting units installed on the machine. This information is used by machine controllers to determine cutting unit reel speed.

Mow Speed identifies the traction speed to be used when in LOW (mow) speed. This information is used by machine controllers to determine cutting unit reel speed.

Height of Cut (HOC) identifies the setting for cutting unit height of cut. This information is used by machine controllers to determine cutting unit reel speed.

F Reel RPM displays the front reel speed that has been determined by the machine controllers based on entered information for blade count, mow speed and HOC. Front reel speed can also be manually adjusted.

R Reel RPM displays the rear reel speed that has been determined by the machine controllers based on entered information for blade count, mow speed and HOC. Rear reel speed can also be manually adjusted.

Economy Mode displays whether the machine has the economy mode feature ON or OFF. When in economy mode with the mow/transport lever in the MOW position, the engine speed is lowered to reduce noise and fuel consumption. When in economy mode with the mow/transport lever in the TRANSPORT position, engine speed is not lowered.

To return to the main menu screen from the settings screen, press the back button (left button).

About Screen

The about screen (Fig. 24) identifies the machine model number, machine serial number and software revisions for the TEC controller. If the machine PIN has been entered to allow protected menu items to be visible, the about screen will also identify software revisions for the cutting unit and motor/generator controller and list the CAN-bus status.

To return to the main menu screen from the about screen, press the back button (left button).

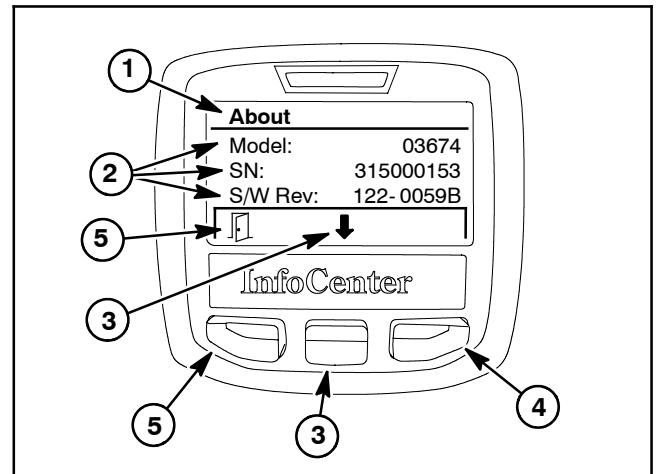



Figure 24

1. About menu
2. About items
3. Move to menu items
4. Choose menu item
5. Back button

Troubleshooting

 CAUTION
Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, there must be a good understanding of the electrical circuits and components used on this machine (see Chapter 9 - Foldout Drawings).

If the machine has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

NOTE: Use the InfoCenter Display to test TEC controller inputs and outputs when troubleshooting an electrical problem on your Reelmaster (see InfoCenter Display in this chapter).

Operator Advisories

If controls are not selected properly to allow certain machine operations, the InfoCenter indicator light will illuminate and an advisory will be displayed on the InfoCenter Display. Typically, an advisory can be eliminated with a change in controls by the operator.

Advisory numbers, descriptions and reason for advisories are listed in the table on the next page. Some advisories can be caused by several machine settings.

NOTE: Icons that are used on the InfoCenter display are identified in the Traction Unit Operator's Manual.

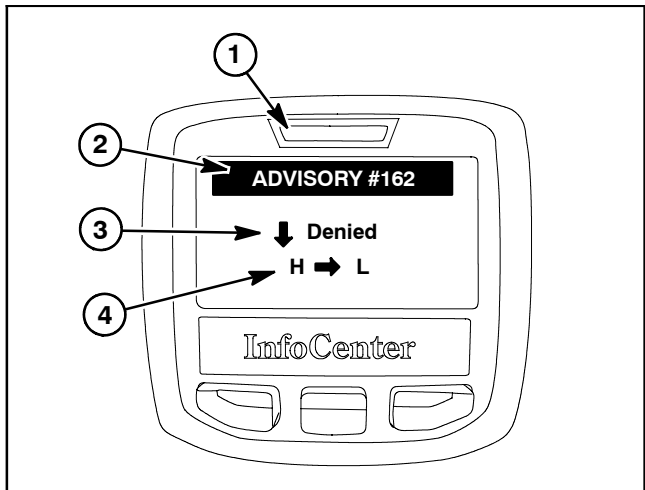


Figure 25

- | | |
|--------------------|-------------------------|
| 1. Indicator light | 3. Advisory description |
| 2. Advisory number | 4. Reason for advisory |

Advisory Number	Advisory Description	Possible Reason for Advisory
160	Start Denied	Neither seat occupied nor parking brake applied Traction pedal is NOT in neutral position Wait to start until system functions have been initialized Joystick is in RAISE position Joystick is in LOWER position Reel engage/disengage switch is in engaged position
161	Mow Denied	No operator in seat Engine coolant temperature is excessive Low voltage in 48 VDC battery pack
162	Lowered Denied	Mow stop lever is in TRANSPORT position
163	Backlap Denied	Traction pedal is not in neutral position Mow stop lever is in TRANSPORT position Engine coolant temperature is excessive Parking brake is NOT applied Reel engage/disengage switch is NOT in engaged position Cutting units are NOT fully lowered
169	Engine Shutdown	No operator in seat Parking brake IS applied Engine coolant temperature is excessive Engine oil pressure is low
170	Recycle Keyswitch (ignition switch)	Engine starter motor has been engaged for 30 seconds
173	Master Address Claim	
175	Check Reel Speed Settings	Check that reel speed settings are correct for cutting units on machine
176	Reel Speed Changed	Identifies that reel speed has been changed
177	Reel Speed Changed Out Of Range	
178	Low 48 VDC Battery	Heavy 48 VDC battery pack use has decreased battery pack charge

Fault Codes

The InfoCenter Display will identify electrical system malfunctions (faults) if they occur. Should a fault occur during machine operation, the InfoCenter indicator light will illuminate and the fault will be displayed on the InfoCenter Display (Fig. 26).

The InfoCenter display faults screen will list all machine electrical faults that have occurred since the faults were last cleared from the InfoCenter. The faults will be identified by a fault number and when the fault occurred.

Fault codes, fault descriptions and recommended service suggestions for fault codes are listed in the table on the following pages.

NOTE: Icons that are used on the InfoCenter display are identified in the Traction Unit Operator's Manual.

NOTE: Fault codes identify electrical problems that typically will prevent normal machine operation. For fault codes that identify problems with TEC controller inputs (e.g. switches, sensors), use the InfoCenter Display to check the different switch positions before removing or replacing the component. Fault codes that identify problems with TEC controller outputs (e.g. solenoid coils) might involve issues with the wire harness or the actual output device.

Using Fault Codes

If an electrical fault is identified by the machine controllers (TEC, motor/generator, cutting unit motors), the InfoCenter display will identify the fault code number and when the fault occurred. An electrical fault can cause disruption in how the machine functions but in some instances, the fault may occur with little, if any, change in machine operation. The following suggestions should be considered when using fault codes that are displayed.

- If a fault code is displayed on the InfoCenter and machine operation remains normal, continue to use the machine. The fault code number can be retrieved in the future by using the InfoCenter faults screen.

- If a fault code is displayed on the InfoCenter and machine operation has changed, move the machine to a level surface, disengage the cutting units and turn the ignition switch to the OFF position. Leave switch in the OFF position for thirty (30) seconds and then restart the machine. During this system reboot process, the machine controllers often can reset electrical components to allow normal machine operation. Assuming that the fault code is no longer displayed, continue to use the machine. The fault code number can be retrieved in the future by using the InfoCenter faults screen.

- There is the possibility that an electrical issue can result with several fault codes being generated. For example, a broken wire or faulty fuse would prevent operation of a cutting unit motor and multiple fault codes could be displayed. Reviewing the fault code descriptions should suggest possible causes for the circuit problem. Using the electrical schematic and electrical wire harness drawings will also help in problem diagnosis.

- The InfoCenter will display fault code numbers as an indication that the machine electrical system has experienced an abnormal change that might be very minor resulting in no change of machine operation or more severe which could prevent machine use. Use fault codes in conjunction with noting what machine operations have changed, when did the change occur and whether the problem occurs all the time or is intermittent to help identify the source of a machine problem.

- The InfoCenter faults screen can be used to list all machine electrical faults that have occurred since the faults were last cleared from the InfoCenter. If a fault that is listed on the InfoCenter faults screen occurred at some point in the distant past and has not reoccurred, that fault is likely not causing a current machine problem. Recurring faults may indicate a problem with a particular circuit or component.

- When machine electrical issues occur and fault codes have been displayed on the InfoCenter display, consider contacting your Toro Distributor for additional assistance.

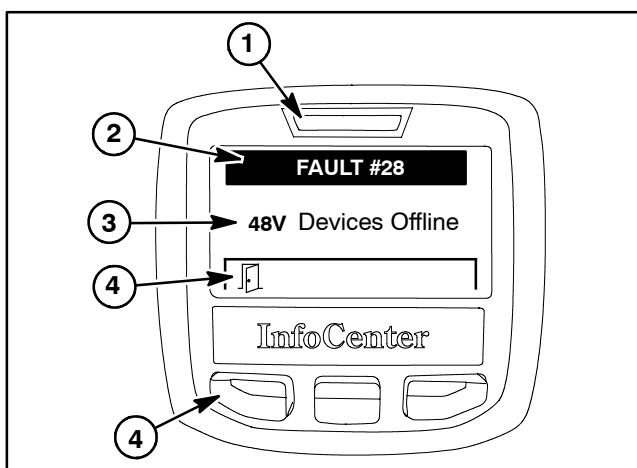


Figure 26

- | | |
|--------------------|----------------------|
| 1. Indicator light | 3. Fault description |
| 2. Fault number | 4. Back button |

Fault Code	Fault Description	Service Suggestions
1	Excessive engine coolant temperature (above 105°C) caused PTO to disengage	Check radiator and screen for debris buildup Check engine cooling fan and drive belt Check engine coolant level
2	Excessive engine coolant temperature (above 115°C) caused engine to stop	Check radiator and screen for debris buildup Check engine cooling fan and drive belt Check engine coolant level
3	One of the TEC output fuses (7.5 Amp) is faulty	Check TEC output fuses
4	IPE voltage is low indicating that TEC fuses or TEC controller is faulty	Check TEC fuses Consider that TEC controller is faulty
5	Main power relay is faulty	Check main power relay and circuit wiring
6	Ignition switch was held in the START position for more than thirty (30) seconds or the ignition switch is faulty	Cycle ignition switch Check fuel level in fuel tank Check ignition switch and circuit wiring Check fuel actuator and fuel pump
7	TEC software needs to be reprogrammed	Contact Toro Distributor for reprogramming assistance
8	Engine alternator charging is too high	Check engine alternator
9	Engine alternator charging is too low	Check alternator drive belt Check engine alternator and circuit wiring
13	Ignition switch is faulty	Check ignition switch and circuit wiring
15	Engine speed switch is faulty	Check control arm engine speed switch and circuit wiring
16	Engine alternator is faulty	Check engine alternator and circuit wiring
17	48 VDC logic relay current is excessive	Check 48V logic relay and circuit wiring
19	Engine coolant temperature sensor circuit has open or short	Check engine coolant sensor and circuit wiring
21	ID Module is faulty	Unplug cutting unit motors one at a time to find a possible faulty cutting unit motor Check ID module and circuit wiring
24	Joystick raise and lower switches closed at same time	Check joystick switches and circuit wiring
26	TEC output current to energize start relay is excessive	Check start relay and circuit wiring
27	TEC output current to fuel pump is excessive	Check fuel pump and circuit wiring

Fault Code	Fault Description	Service Suggestions
28	48 VDC devices (motor/generator and all cutting reel motors) are all off-line	Make sure that 48 VDC battery disconnect is securely plugged in Check 10A logic relay fuse Check 48 VDC master fuse (250A maxi fuse) Check 48 VDC battery system voltage Check 48 VDC logic relay and circuit wiring Check isolation module and circuit wiring Check CAN- bus termination resistors and circuit wiring
29	48 VDC system (motor/generator and all cutting reel motors) is under voltage	Check 48 VDC battery voltage Check 48 VDC battery connections Check internal motor/generator connections Consider that motor/generator is faulty
30	48 VDC system (motor/generator and all cutting reel motors) is over voltage	Check 48 VDC battery voltage If engine is running when fault occurred, check internal motor/generator connections Consider that motor/generator is faulty
31	48 VDC system (motor/generator and all cutting reel motors) logic voltage are all excessive	Check 48 VDC battery voltage If engine is running when fault occurred, check internal motor/generator connections Consider that motor/generator is faulty
32	Cutting unit fault	Contact Toro distributor for cutting unit service assistance
33	Motor/generator fault	Contact Toro distributor for motor/generator service assistance
34	Master (TEC controller) fault	Contact Toro distributor for TEC service assistance
37	TEC output current to energize glow relay is excessive	Check glow relay and circuit wiring
38	CAN- bus fault for #1 cutting reel motor	Check CAN- bus connection to #1 motor Verify battery power exists at #1 motor Check CAN- bus termination resistors
39	CAN- bus fault for #2 cutting reel motor	Check CAN- bus connection to #2 motor Verify battery power exists at #2 motor Check CAN- bus termination resistors
40	CAN- bus fault for #3 cutting reel motor	Check CAN- bus connection to #3 motor Verify battery power exists at #3 motor Check CAN- bus termination resistors
41	CAN- bus fault for #4 cutting reel motor	Check CAN- bus connection to #4 motor Verify battery power exists at #4 motor Check CAN- bus termination resistors
42	CAN- bus fault for #5 cutting reel motor	Check CAN- bus connection to #5 motor Verify battery power exists at #5 motor Check CAN- bus termination resistors

Fault Code	Fault Description	Service Suggestions
43	CAN- bus fault for motor/generator	Check CAN- bus connection to motor/generator Verify battery power exists at motor/generator Check CAN- bus termination resistors
44	CAN- bus fault for InfoCenter	Check CAN- bus connection to InfoCenter Display Verify battery power exists at InfoCenter Display Check CAN- bus termination resistors
45	Software version incompatible with #1 cutting reel motor	Contact Toro distributor to update software
46	Software version incompatible with #2 cutting reel motor	Contact Toro distributor to update software
47	Software version incompatible with #3 cutting reel motor	Contact Toro distributor to update software
48	Software version incompatible with #4 cutting reel motor	Contact Toro distributor to update software
49	Software version incompatible with #5 cutting reel motor	Contact Toro distributor to update software
50	Software version incompatible with motor/generator	Contact Toro distributor to update software
51	Software version incompatible with InfoCenter	Contact Toro distributor to update software
52	Software version incompatible within entire system	Contact Toro distributor to update software
53	TEC output current for hydraulic solenoid coil SV1 is excessive	Check lift manifold solenoid coil SV1 and circuit wiring
54	TEC output current for hydraulic solenoid coil SV2 is excessive	Check lift manifold solenoid coil SV2 and circuit wiring
55	TEC output current for hydraulic solenoid coil SV3 is excessive	Check lift manifold solenoid coil SV3 and circuit wiring
56	TEC output current for hydraulic solenoid coil SVRV is excessive	Check lift manifold solenoid coil SVRV and circuit wiring
57	Cutting unit motor sizes (5" and 7") are mixed	Check that all 5 cutting unit motors are for the same size cutting unit on the machine
58	Current sensor fault in motor/generator controller	Motor/generator controller is faulty if this fault continues to occur (generator motor should be OK)
59	Line contactor - open fault	Check main contactor and circuit wiring Replace main contactor if faulty
60	Line contactor - closed fault	Check main contactor and circuit wiring Replace main contactor if faulty
61	Line contactor - over current	Motor/generator is faulty if this fault continues to occur
62	Fault latch - phase OC	Motor/generator is faulty if this fault continues to occur

Fault Code	Fault Description	Service Suggestions
63	48 VDC pre- charge fault	<p>Disconnect one cutting reel motor at a time until the fault is no longer active to identify faulty motor</p> <p>NOTE: If cutting reel motor is faulty, additional fault codes will likely be displayed</p>
64	Motor/generator temperature sensor fault	If this fault continues to occur, consider that motor/generator may be faulty
65	Motor stalled on #1 cutting unit	<p>Check #1 cutting unit for excessive rotating resistance</p> <p>Check #1 cutting unit bedknife adjustment and reel condition</p> <p>Check #1 cutting unit motor for excessive rotating resistance</p> <p>Check that #1 cutting unit motor can rotate without load</p> <p>Replace #1 cutting unit motor if above items do not identify problem and issue is not resolved</p>
66	Motor stalled on #2 cutting unit	<p>Check #2 cutting unit for excessive rotating resistance</p> <p>Check #2 cutting unit bedknife adjustment and reel condition</p> <p>Check #2 cutting unit motor for excessive rotating resistance</p> <p>Check that #2 cutting unit motor can rotate without load</p> <p>Replace #2 cutting unit motor if above items do not identify problem and issue is not resolved</p>
67	Motor stalled on #3 cutting unit	<p>Check #3 cutting unit for excessive rotating resistance</p> <p>Check #3 cutting unit bedknife adjustment and reel condition</p> <p>Check #3 cutting unit motor for excessive rotating resistance</p> <p>Check that #3 cutting unit motor can rotate without load</p> <p>Replace #3 cutting unit motor if above items do not identify problem and issue is not resolved</p>

Fault Code	Fault Description	Service Suggestions
68	Motor stalled on #4 cutting unit	<p>Check #4 cutting unit for excessive rotating resistance</p> <p>Check #4 cutting unit bedknife adjustment and reel condition</p> <p>Check #4 cutting unit motor for excessive rotating resistance</p> <p>Check that #4 cutting unit motor can rotate without load</p> <p>Replace #4 cutting unit motor if above items do not identify problem and issue is not resolved</p>
69	Motor stalled on #5 cutting unit	<p>Check #5 cutting unit for excessive rotating resistance</p> <p>Check #5 cutting unit bedknife adjustment and reel condition</p> <p>Check #5 cutting unit motor for excessive rotating resistance</p> <p>Check that #5 cutting unit motor can rotate without load</p> <p>Replace #5 cutting unit motor if above items do not identify problem and issue is not resolved</p>
70	High temperature warning for #1 cutting unit	<p>Let machine cool to lower cutting unit motor temperature</p> <p>Open the rear discharge of the cutting unit</p> <p>Reduce reel speed if possible</p> <p>Reduce mow speed if possible</p> <p>If fault does not seem to be related to cutting load conditions, check 48 VDC ground for #1 cutting unit motor</p> <p>Consider replacement of #1 cutting unit motor if this fault continues to occur</p> <p>NOTE: A faulty sensor will not cause this fault</p>
71	High temperature warning for #2 cutting unit	<p>Let machine cool to lower cutting unit motor temperature</p> <p>Open the rear discharge of the cutting unit</p> <p>Reduce reel speed if possible</p> <p>Reduce mow speed if possible</p> <p>If fault does not seem to be related to cutting load conditions, check 48 VDC ground for #2 cutting unit motor</p> <p>Consider replacement of #2 cutting unit motor if this fault continues to occur</p> <p>NOTE: A faulty sensor will not cause this fault</p>

Fault Code	Fault Description	Service Suggestions
72	High temperature warning for #3 cutting unit	<p>Let machine cool to lower cutting unit motor temperature</p> <p>Open the rear discharge of the cutting unit</p> <p>Reduce reel speed if possible</p> <p>Reduce mow speed if possible</p> <p>If fault does not seem to be related to cutting load conditions, check 48 VDC ground for #3 cutting unit motor</p> <p>Consider replacement of #3 cutting unit motor if this fault continues to occur</p> <p>NOTE: A faulty sensor will not cause this fault</p>
73	High temperature warning for #4 cutting unit	<p>Let machine cool to lower cutting unit motor temperature</p> <p>Open the rear discharge of the cutting unit</p> <p>Reduce reel speed if possible</p> <p>Reduce mow speed if possible</p> <p>If fault does not seem to be related to cutting load conditions, check 48 VDC ground for #4 cutting unit motor</p> <p>Consider replacement of #4 cutting unit motor if this fault continues to occur</p> <p>NOTE: A faulty sensor will not cause this fault</p>
74	High temperature warning for #5 cutting unit	<p>Let machine cool to lower cutting unit motor temperature</p> <p>Open the rear discharge of the cutting unit</p> <p>Reduce reel speed if possible</p> <p>Reduce mow speed if possible</p> <p>If fault does not seem to be related to cutting load conditions, check 48 VDC ground for #5 cutting unit motor</p> <p>Consider replacement of #5 cutting unit motor if this fault continues to occur</p> <p>NOTE: A faulty sensor will not cause this fault</p>

Fault Code	Fault Description	Service Suggestions
75	High temperature warning for motor/generator	<p>Make sure that hood screen is clean</p> <p>Check that air intake to motor/generator is not restricted or blocked and that air is moving through intake when engine is running</p> <p>Check for motor/generator cooling fin debris obstruction</p> <p>Let machine cool to lower motor/generator temperature</p> <p>Reduce cutting system load by reducing reel speed, reducing mow speed or by opening the rear discharge of the cutting unit</p> <p>If this fault continues to occur when the machine is not at full operating temperature, consider that the motor/generator is faulty</p> <p>NOTE: A faulty sensor will not cause this fault</p>
76	System voltage under 32 VDC has disabled #1 cutting unit	<p>Check logic power connection to #1 cutting unit</p> <p>If this fault is displayed for more than one cutting unit, check 48 VDC battery voltage when engine is OFF and also check 48 VDC logic relay and circuit wiring</p> <p>If 48 VDC battery voltage is correct when engine is OFF but drops when engine is ON, consider that motor/generator is faulty</p>
77	System voltage under 32 VDC has disabled #2 cutting unit	<p>Check logic power connection to #2 cutting unit</p> <p>If this fault is displayed for more than one cutting unit, check 48 VDC battery voltage when engine is OFF and also check 48 VDC logic relay and circuit wiring</p> <p>If 48 VDC battery voltage is correct when engine is OFF but drops when engine is ON, consider that motor/generator is faulty</p>
78	System voltage under 32 VDC has disabled #3 cutting unit	<p>Check logic power connection to #3 cutting unit</p> <p>If this fault is displayed for more than one cutting unit, check 48 VDC battery voltage when engine is OFF and also check 48 VDC logic relay and circuit wiring</p> <p>If 48 VDC battery voltage is correct when engine is OFF but drops when engine is ON, consider that motor/generator is faulty</p>

Fault Code	Fault Description	Service Suggestions
79	System voltage under 32 VDC has disabled #4 cutting unit	<p>Check logic power connection to #4 cutting unit</p> <p>If this fault is displayed for more than one cutting unit, check 48 VDC battery voltage when engine is OFF and also check 48 VDC logic relay and circuit wiring</p> <p>If 48 VDC battery voltage is correct when engine is OFF but drops when engine is ON, consider that motor/generator is faulty</p>
80	System voltage under 32 VDC has disabled #5 cutting unit	<p>Check logic power connection to #5 cutting unit</p> <p>If this fault is displayed for more than one cutting unit, check 48 VDC battery voltage when engine is OFF and also check 48 VDC logic relay and circuit wiring</p> <p>If 48 VDC battery voltage is correct when engine is OFF but drops when engine is ON, consider that motor/generator is faulty</p>
81	System voltage under 36 VDC has disabled motor/generator	<p>Check logic power connection to motor/generator</p> <p>If this fault is also displayed for cutting unit(s), check 48 VDC battery voltage when engine is OFF and also check 48 VDC logic relay and circuit wiring</p> <p>If 48 VDC battery voltage is correct when engine is OFF but drops when engine is ON, consider that motor/generator is faulty</p>
82	Logic voltage over 67.5 VDC has disabled #1 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48 VDC components (motor/generator and cutting unit motors) generate this fault, system fault 31 will be displayed on the InfoCenter</p>

Fault Code	Fault Description	Service Suggestions
83	Logic voltage over 67.5 VDC has disabled #2 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48 VDC components (motor/generator and cutting unit motors) have this fault, system fault 31 will be displayed on the Info-Center</p>
84	Logic voltage over 67.5 VDC has disabled #3 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48 VDC components (motor/generator and cutting unit motors) generate this fault, system fault 31 will be displayed on the InfoCenter</p>
85	Logic voltage over 67.5 VDC has disabled #4 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48 VDC components (motor/generator and cutting unit motors) have this fault, system fault 31 will be displayed on the Info-Center</p>

Fault Code	Fault Description	Service Suggestions
86	Logic voltage over 67.5 VDC has disabled #5 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 31 will be displayed on the InfoCenter</p>
87	Logic voltage over 65 VDC has disabled motor/generator	<p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 31 will be displayed on the InfoCenter</p>
88	System bus voltage under 32 VDC has disabled #1 cutting unit (main contactor is engaged)	<p>Check 35A reel motor fuse for #1 cutting unit</p> <p>Check the 2 pin 48 VDC bus connector for the #1 cutting unit</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 29 will be displayed on the InfoCenter</p>
89	System bus voltage under 32 VDC has disabled #2 cutting unit (main contactor is engaged)	<p>Check 35A reel motor fuse for #2 cutting unit</p> <p>Check the 2 pin 48 VDC bus connector for the #2 cutting unit</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 29 will be displayed on the InfoCenter</p>
90	System bus voltage under 32 VDC has disabled #3 cutting unit (main contactor is engaged)	<p>Check 35A reel motor fuse for #3 cutting unit</p> <p>Check the 2 pin 48 VDC bus connector for the #3 cutting unit</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 29 will be displayed on the InfoCenter</p>
91	System bus voltage under 32 VDC has disabled #4 cutting unit (main contactor is engaged)	<p>Check 35A reel motor fuse for #4 cutting unit</p> <p>Check the 2 pin 48 VDC bus connector for the #4 cutting unit</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 29 will be displayed on the InfoCenter</p>
92	System bus voltage under 32 VDC has disabled #5 cutting unit (main contactor is engaged)	<p>Check 35A reel motor fuse for #5 cutting unit</p> <p>Check the 2 pin 48 VDC bus connector for the #5 cutting unit</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 29 will be displayed on the InfoCenter</p>

Fault Code	Fault Description	Service Suggestions
93	System bus voltage under 36 VDC has disabled motor/generator (main contactor is engaged)	<p>Check to see if a pre-charge fault (fault 63) has occurred</p> <p>Check that main contactor is functional</p> <p>Check the motor/generator connections</p> <p>NOTE: If all 48 VDC components (motor/generator and cutting unit motors) have this fault, system fault 29 will be displayed on the Info-Center</p>
94	System bus voltage over 67.5 VDC has disabled #1 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48 VDC components (motor/generator and cutting unit motors) have this fault, system fault 30 will be displayed on the Info-Center</p>
95	System bus voltage over 67.5 VDC has disabled #2 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 30 will be displayed on the InfoCenter</p>
96	System bus voltage over 67.5 VDC has disabled #3 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 30 will be displayed on the InfoCenter</p>

Fault Code	Fault Description	Service Suggestions
97	System bus voltage over 67.5 VDC has disabled #4 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 30 will be displayed on the InfoCenter</p>
98	System bus voltage over 67.5 VDC has disabled #5 cutting unit	<p>If multiple cutting units are reporting this fault, check 48 VDC batteries and motor/generator operation</p> <p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>If TEC controller has lost communication with motor/generator, engine speed will not be controllable and this fault may be displayed</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 30 will be displayed on the InfoCenter</p>
99	System bus voltage over 65 VDC has disabled motor/generator	<p>If 48 VDC batteries are at correct voltage with engine OFF, consider connections between motor/generator and motor/generator controller are loose or faulty</p> <p>NOTE: If all 48V components (motor/generator and cutting unit motors) have this fault, system fault 30 will be displayed on the InfoCenter</p>
100	Excessive system current has disabled #1 cutting unit	#1 cutting unit motor is likely faulty if this fault continues to occur
101	Excessive system current has disabled #2 cutting unit	#2 cutting unit motor is likely faulty if this fault continues to occur
102	Excessive system current has disabled #3 cutting unit	#3 cutting unit motor is likely faulty if this fault continues to occur
103	Excessive system current has disabled #4 cutting unit	#4 cutting unit motor is likely faulty if this fault continues to occur
104	Excessive system current has disabled #5 cutting unit	#5 cutting unit motor is likely faulty if this fault continues to occur
105	Excessive system current has disabled motor/generator	Motor/generator is likely faulty if this fault continues to occur
106	Excessive voltage occurred at internal motor regulator for #1 cutting unit	#1 cutting unit motor is likely faulty if this fault continues to occur
107	Excessive voltage occurred at internal motor regulator for #2 cutting unit	#2 cutting unit motor is likely faulty if this fault continues to occur

Fault Code	Fault Description	Service Suggestions
108	Excessive voltage occurred at internal motor regulator for #3 cutting unit	#3 cutting unit motor is likely faulty if this fault continues to occur
109	Excessive voltage occurred at internal motor regulator for #4 cutting unit	#4 cutting unit motor is likely faulty if this fault continues to occur
110	Excessive voltage occurred at internal motor regulator for #5 cutting unit	#5 cutting unit motor is likely faulty if this fault continues to occur
111	Excessive voltage occurred at internal motor/generator regulator and disabled motor/generator	Motor/generator is likely faulty if this fault continues to occur
112	Insufficient voltage occurred at internal motor regulator for #1 cutting unit and disabled motor	Check electrical connections to #1 cutting unit motor If fault occurs for multiple cutting unit motors, check 48 VDC logic relay and circuit wiring Check 48 VDC battery system cables for proper connections Consider that #1 cutting unit motor is faulty
113	Insufficient voltage occurred at internal motor regulator for #2 cutting unit and disabled motor	Check electrical connections to #2 cutting unit motor If fault occurs for multiple cutting unit motors, check 48 VDC logic relay and circuit wiring Check 48 VDC battery system cables for proper connections Consider that #2 cutting unit motor is faulty
114	Insufficient voltage occurred at internal motor regulator for #3 cutting unit and disabled motor	Check electrical connections to #3 cutting unit motor If fault occurs for multiple cutting unit motors, check 48 VDC logic relay and circuit wiring Check 48 VDC battery system cables for proper connections Consider that #3 cutting unit motor is faulty
115	Insufficient voltage occurred at internal motor regulator for #4 cutting unit and disabled motor	Check electrical connections to #4 cutting unit motor If fault occurs for multiple cutting unit motors, check 48 VDC logic relay and circuit wiring Check 48 VDC battery system cables for proper connections Consider that #4 cutting unit motor is faulty
116	Insufficient voltage occurred at internal motor regulator for #5 cutting unit and disabled motor	Check electrical connections to #5 cutting unit motor If fault occurs for multiple cutting unit motors, check 48 VDC logic relay and circuit wiring Check 48 VDC battery system cables for proper connections Consider that #5 cutting unit motor is faulty

Fault Code	Fault Description	Service Suggestions
117	Insufficient voltage occurred at internal motor/generator regulator and disabled motor/generator	<p>Check electrical connections to motor/generator</p> <p>If fault occurs for multiple cutting unit motors and motor/generator, check 48 VDC logic relay and circuit wiring</p> <p>Check 48 VDC battery system cables for proper connections</p> <p>Consider that motor/generator is faulty</p>
123	Excessive motor/generator speed	Engine speed is incorrect which causes the motor/generator to overspeed
124	Hall effect sensors in #1 cutting unit motor are providing different feedback	#1 cutting unit motor is likely faulty if this fault continues to occur
125	Hall effect sensors in #2 cutting unit motor are providing different feedback	#2 cutting unit motor is likely faulty if this fault continues to occur
126	Hall effect sensors in #3 cutting unit motor are providing different feedback	#3 cutting unit motor is likely faulty if this fault continues to occur
127	Hall effect sensors in #4 cutting unit motor are providing different feedback	#4 cutting unit motor is likely faulty if this fault continues to occur
128	Hall effect sensors in #5 cutting unit motor are providing different feedback	#5 cutting unit motor is likely faulty if this fault continues to occur
129	Hall effect sensors in motor/generator are providing different feedback	<p>Motor/generator is likely faulty if this fault continues to occur</p> <p>NOTE: If engine speed is erratic when this fault is displayed, the motor/generator will likely need to be replaced</p>

Starting Problems

Problem	Possible Causes
<p>All electrical power is dead, including InfoCenter Display.</p>	<p>12 VDC battery is discharged.</p> <p>Ignition switch or circuit wiring is faulty.</p> <p>Fusible link harness at the engine starter motor is faulty.</p> <p>12 VDC battery cables are loose or corroded.</p> <p>Main fuse (15 amp) to the ignition switch is faulty.</p>
<p>Starter solenoid clicks, but starter will not crank.</p> <p>NOTE: If the starter solenoid clicks, the problem is not in the interlock circuit.</p>	<p>12 VDC battery is discharged.</p> <p>12 VDC battery cables are loose or corroded.</p> <p>Ground cable is loose or corroded.</p> <p>Wiring at the starter motor is faulty.</p> <p>Starter solenoid or starter motor is faulty.</p>
<p>Engine starts, but stops when the ignition switch is released from the START position.</p>	<p>Engine fuel actuator or circuit wiring is faulty.</p> <p>Engine or fuel system is malfunctioning (see Chapter 3 - Kubota Diesel Engine).</p>
<p>Engine cranks, but does not start.</p> <p>NOTE: After 30 seconds of engine cranking, the TEC controller output to the engine starter motor will de-energize even if the ignition switch is kept in the START position. This is designed to prevent overheating of the starter motor.</p>	<p>Engine and/or fuel may be too cold.</p> <p>Fuel tank is empty.</p> <p>Glow plugs, glow plug relay or circuit wiring is faulty.</p> <p>Engine fuel actuator or circuit wiring is faulty.</p> <p>Engine fuel filter is clogged.</p> <p>Engine or fuel system is malfunctioning (see Chapter 3 - Kubota Diesel Engine).</p>
<p>Engine cranks, but should not, when the traction pedal is depressed.</p>	<p>Traction neutral switch is out of adjustment.</p> <p>Traction neutral switch or circuit wiring is faulty.</p>

Starting Problems (Continued)

Problem	Possible Causes
<p>Nothing happens when start attempt is made. InfoCenter Display operates with the ignition switch in RUN.</p> <p>NOTE: If machine controls are not in the correct position to start the engine (e.g. the traction pedal is pressed), an advisory message may be displayed on the InfoCenter Display.</p>	<p>Traction pedal is not in neutral position.</p> <p>Operator seat is unoccupied OR the parking brake is not applied.</p> <p>Cutting units are engaged (reel engage/disengage switch is ON).</p> <p>The joystick is not in the center position.</p> <p>Traction neutral switch is out of adjustment.</p> <p>Traction neutral switch or circuit wiring is faulty.</p> <p>Seat switch or circuit wiring is faulty.</p> <p>Parking brake switch or circuit wiring is faulty.</p> <p>Joystick switch (raise or lower position) is faulty.</p> <p>Ignition switch or circuit wiring is faulty.</p> <p>Start relay or circuit wiring is faulty.</p> <p>Main power relay or circuit wiring is faulty (headlights and powerpoint inoperative as well).</p> <p>TEC controller fuses are faulty.</p> <p>Fusible link at battery is open.</p> <p>Wiring to start circuit components is loose, corroded or damaged (see electrical drawings in Chapter 9 - Foldout Drawings).</p> <p>Temperature sender or circuit wiring is faulty.</p> <p>Starter solenoid or starter motor is faulty.</p> <p>TEC controller is faulty.</p>

General Run and Transport Problems

Problem	Possible Causes
Engine continues to run, but should not, when the ignition switch is turned off.	Engine fuel actuator or circuit wiring is faulty. Ignition switch or circuit wiring is faulty. Main power relay or circuit wiring is faulty.
Engine continues to run, but should not, when the traction pedal is engaged with no operator in the seat.	Seat switch or circuit wiring is faulty. TEC controller fuses are faulty. Traction neutral switch is out of adjustment. Traction neutral switch or circuit wiring is faulty. TEC controller is faulty.
The engine stops during operation, but is able to restart. NOTE: If excessive coolant temperature or low engine oil pressure causes engine shutdown, the operator can restart the engine to allow the machine to be moved a short distance. After a restart in this condition, the engine will run for approximately ten (10) seconds before the engine shuts down again unless engine temperature has decreased or oil pressure issue has been resolved.	Parking brake is engaged. Operator is raising from the seat (seat switch not fully depressed). Seat switch or circuit wiring is faulty. Temperature sender or circuit wiring is faulty. Ignition switch or circuit wiring is faulty.
The engine kills when the traction pedal is depressed. NOTE: If machine controls are not in the correct position for operating the machine (e.g. the parking brake is engaged), an advisory message may be displayed on the InfoCenter Display.	Parking brake is engaged. Operator is not fully depressing the seat switch. TEC controller fuses are faulty. Seat switch or circuit wiring is faulty. TEC controller fuses are faulty. TEC controller is faulty.
12 VDC battery does not charge.	Wiring to alternator or other charging circuit components is loose, corroded or damaged (see Electrical Schematic and Wire Harness Drawings in Chapter 9 - Foldout Drawings). Alternator belt is loose or damaged. 12 VDC battery cables are loose or corroded. Fusible link harness at the engine starter motor is faulty. Alternator is faulty. 12 VDC battery is faulty.

Cutting Unit Operating Problems

Problem	Possible Causes
The cutting units remain engaged, but should not, with no operator in the seat.	Seat switch or circuit wiring is faulty. TEC controller is faulty.
Cutting units run, but should not, when raised. Cutting units shut off with reel engage/disengage switch.	Cutting unit down limit switch or circuit wiring is faulty. TEC controller is faulty.
Cutting units run, but should not, when raised. Cutting units do not shut off with reel engage/disengage switch.	Both the cutting unit down limit switch (or circuit wiring) and reel engage/disengage switch switch (or circuit wiring) are faulty. TEC controller is faulty.
None of the cutting units operate in either direction (mow or backlap). Cutting units are able to raise and lower. NOTE: If machine controls are not in the correct position to engage the cutting units, an advisory message may be displayed on the InfoCenter Display.	Reel engage/disengage switch is in the OFF position. Mow stop lever is not in the MOW position. Operator seat is unoccupied. The 48 VDC battery disconnect is unplugged or damaged. Logic or Maxi fuse for 48 VDC system is faulty. High engine coolant temperature has disabled cutting unit operation. Seat switch or circuit wiring is faulty. Reel engage/disengage switch or circuit wiring is faulty. Cutting unit down limit switch or circuit wiring is faulty. Mow/transport switch or circuit wiring is faulty. Temperature sender or circuit wiring is faulty.
Cutting units run, but should not, when lowered with joystick and reel engage/disengage switch in the OFF position.	The reel engage/disengage switch or circuit wiring is faulty. TEC controller is faulty.
Individual cutting unit does not operate in either direction (mow or backlap). Other cutting units operate. All cutting units are able to raise and lower.	Fuse for affected cutting unit motor is faulty. Electrical connections to affected cutting unit motor are loose or faulty. Problem exists with affected cutting unit (see Chapter 7 - Cutting Units). Cutting unit motor is damaged. NOTE: If appropriate, transfer a suspected damaged motor to another cutting unit. If problem follows the motor, motor needs repair or replacement.

Cutting Unit Operating Problems (Continued)

Problem	Possible Causes
<p>The cutting units do not run when placed in the backlap direction.</p>	<p>The parking brake is not applied.</p> <p>Reel engage/disengage switch is in the OFF position.</p> <p>High engine coolant temperature has disabled cutting unit operation.</p> <p>The joystick is not in the center position.</p> <p>Cutting units are not fully lowered to ground.</p> <p>Cutting unit down limit switch or circuit wiring is faulty.</p>
<p>None of the cutting units will lower.</p> <p>NOTE: If machine controls are not in the correct position to lower the cutting units, an advisory message may be displayed on the InfoCenter Display.</p>	<p>Mow stop lever is in the TRANSPORT position.</p> <p>Lower/mow switch on joystick or circuit wiring is faulty.</p> <p>Mow/transport switch or circuit wiring is faulty.</p> <p>Hydraulic lift manifold solenoid SVRV or circuit wiring is faulty.</p> <p>Hydraulic lift manifold solenoid SV2 or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p>
<p>None of the cutting units will raise.</p>	<p>Cutting circuit is in the backlap position.</p> <p>Raise switch on joystick or circuit wiring is faulty.</p> <p>Hydraulic lift manifold solenoid SVRV or circuit wiring is faulty.</p> <p>Hydraulic lift manifold solenoid SV2 or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p>
<p>Front cutting units will not raise or lower, but the rear cutting units will raise and lower.</p>	<p>Hydraulic lift manifold solenoid SV1 or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p>
<p>The rear cutting units will not raise or lower, but the front cutting units will raise and lower.</p>	<p>Hydraulic lift manifold solenoid SV3 or circuit wiring is faulty.</p> <p>A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p>
<p>One cutting unit (either front or rear) will not raise or lower, but all other cutting units will raise and lower.</p>	<p>Binding of lift cylinder or lift components for affected cutting unit exists.</p> <p>A hydraulic problem exists (see Troubleshooting section of Chapter 4 - Hydraulic System).</p>

Electrical System Quick Checks

12 VDC Battery Test (Open Circuit Test)

Use a digital multimeter to measure the battery voltage.

Remove battery cover to access the battery at the rear of the machine. Set the multimeter to the DC volts setting. The battery should be at a temperature of 60° to 100° F (16° to 38° C). The ignition switch should be in the OFF position and all accessories turned off. Connect the positive (+) multimeter lead to the positive battery post and the negative (-) multimeter lead to the negative battery post. Record the battery voltage.

NOTE: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information (see Battery Service in the Service and Repairs section of this chapter).

Voltage Measured	Battery Charge Level
12.68 volts or above	Fully charged (100%)
12.45 volts	75% charged
12.24 volts	50% charged
12.06 volts	25% charged
11.89 volts or below	0% charged

Engine Charging System Test

This is a simple test used to determine if the engine charging system is functioning. It will tell you if the charging system has an output, but not its capacity.

Remove battery cover to access the battery at the rear of the machine. Use a digital multimeter set to DC volts. Connect the positive (+) multimeter lead to the positive battery post and the negative (-) multimeter lead to the negative battery post. Keep the test leads connected to the battery posts and record the initial battery voltage.

NOTE: Upon starting the engine, the battery voltage will drop and then should increase once the engine is running.

NOTE: Depending upon the condition of the battery charge and battery temperature, the battery voltage will increase at different rates as the battery charges.

Start the engine and run at high idle (**3000 RPM**). Allow the battery to charge for at least three (3) minutes. Record the battery voltage.

After running the engine for at least three (3) minutes, battery voltage should be at least 0.50 volt higher than initial battery voltage.

An example of a charging system that is functioning:

At least 0.50 volt over initial battery voltage.	
Initial Battery Voltage	= 12.30 V
Battery Voltage after 3 Minute Charge	= 12.95 V
Difference	= +0.65 V

Glow Plug System Test

This is a fast, simple test that can help to determine the integrity and operation of your Reelmaster 5010- H glow plug system. The test should be run anytime hard starting (cold engine) is encountered on a diesel engine equipped with a glow plug system.

Use a digital multimeter and/or inductive Ammeter (AC/DC Current Transducer). Properly connect the ammeter to the digital multimeter (refer to manufacturer's instructions) and set the multimeter to the correct scale. With the ignition switch in the OFF position, place the

ammeter pickup around the main glow plug power supply wire and read the meter prior to activating the glow plug system. Adjust the meter to read zero (if applicable). Activate the glow plug system by turning the ignition switch to ON/PREHEAT and record the multimeter results.

The Reelmaster 5010- H glow plug system should have a reading of approximately 27 Amps total (9 Amps per glow plug). If low current reading is observed during the test, one (or more) glow plugs is faulty.

Check Operation of Interlock Switches



CAUTION

The interlock switches are for the protection of the operator and bystanders and to ensure correct operation of the machine. Do not bypass or disconnect switches. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

Interlock switch operation is described in the Traction Unit Operator's Manual. Your Reelmaster is equipped with an Toro Electronic Controller (TEC) which monitors interlock switch operation. Information on the TEC is described in the Traction Unit Operator's Manual and in the Component Testing section of this Chapter.

The interlock system used on your Reelmaster includes the seat switch, the traction neutral switch, the parking brake switch, the cutting unit down limit switch, the mow/transport switch and the cutting reel engage/disengage switch. Testing of individual interlock switches is included in the Component Testing section of this Chapter.

NOTE: Use the InfoCenter Display to test TEC controller inputs and outputs before further troubleshooting of an electrical problem on your Reelmaster. Inputs and outputs can be tested using the InfoCenter Diagnostic menu (see InfoCenter Display in this chapter).

Adjustments

Traction Neutral Switch

The traction neutral switch is a normally open proximity switch that closes when the traction pedal is in the neutral position. The switch mounts to a bracket on the traction pump. The sensing element for the traction neutral switch is the traction pump lever that is secured to the pump control arm (Fig. 27).

Adjustment

1. Before adjusting the traction neutral switch, check and adjust traction system neutral position (refer to Traction Unit Operator's Manual).

IMPORTANT: To prevent traction neutral switch damage, make sure that no components contact switch through entire traction pump control arm movement.

2. When the traction lever is in the neutral position, the clearance between the head of traction neutral switch and the traction lever bracket should be from **0.094" to 0.100" (2.4 to 2.5 mm)**.

3. If clearance is incorrect, loosen jam nuts that secure neutral switch to pump bracket. Position switch with jam nuts to allow correct clearance between switch and traction lever bracket. Jam nuts should be torqued from **162 to 198 in-lb (18.4 to 22.4 N-m)**. After jam nuts are tightened, make sure that clearance has not changed.

4. After adjustment to the traction neutral switch, use the InfoCenter Display to verify that traction neutral switch and circuit wiring **are** functioning correctly (see Diagnostics Screen (Engine Run item) in the InfoCenter Display section of this chapter).

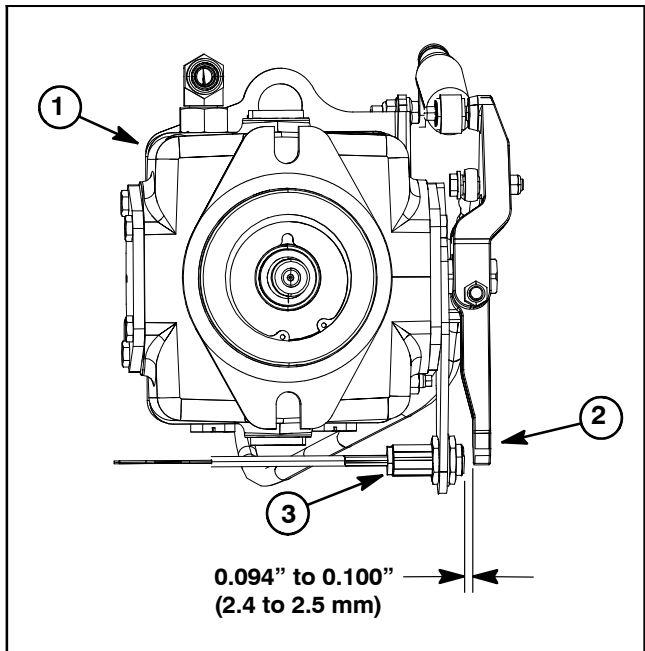


Figure 27

- 1. Traction pump
- 2. Traction pump lever
- 3. Traction neutral switch

Parking Brake Switch

The parking brake switch is a normally open proximity switch. The parking brake switch is attached to the bottom of the brake pedal (Fig. 28).

When the parking brake is not applied, the parking brake detent is positioned near the target end of the parking brake switch so the switch is closed. The parking brake detent is moved away from the switch when the parking brake is applied causing the switch to open.

Adjustment

The distance between the parking brake switch and the tab on the parking brake detent should be from **0.094" to 0.100" (2.4 to 2.5 mm)** when the parking brake is not applied. If distance is incorrect, loosen jam nuts that secure brake switch to brake pedal. Position switch with jam nuts to allow correct clearance between switch and brake detent tab. Jam nuts should be torqued from **162 to 198 in-lb (18.4 to 22.4 N-m)**. After jam nuts are tightened, make sure that clearance has not changed.

After adjustment to the parking brake switch, use the InfoCenter Display to verify that brake switch and circuit wiring **are** functioning correctly (see Diagnostics Screen (Engine Run item) in the InfoCenter Display section of this chapter).

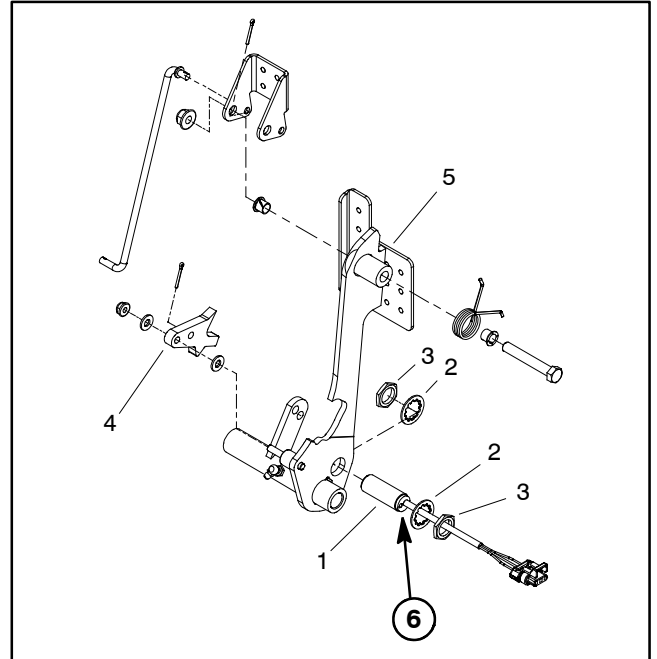


Figure 28

- | | |
|-------------------------|-------------------------|
| 1. Parking brake switch | 4. Parking brake detent |
| 2. Lock washer (2 used) | 5. Brake pedal |
| 3. Jam nut (2 used) | 6. Switch LED location |

Cutting Unit Down Limit Switch

The cutting unit down limit switch is a normally open proximity switch that closes when the front, outside cutting units are in the turn-around position. The down limit switch is attached to a frame bracket inside the front, right lift arm pivot tube. A bracket on the front, right lift arm acts as the sensing plate for the down limit switch (Fig. 29).

Adjustment

The down limit switch should be secured to the switch bracket at the midpoint of the bracket mounting slots.

NOTE: The vertical location of the down limit switch on the switch bracket will determine the turn-around position of the front, outside cutting units (cutting units #4 and #5). Raising the switch on the bracket will allow a lower turn-around position of the cutting units. Lowering the switch on the bracket will allow a higher turn-around position of the cutting units.

The distance between the down limit switch and the sensing plate on lift arm should be from **0.094" to 0.100" (2.4 to 2.5 mm)**. If distance is incorrect, loosen jam nuts that secure down limit switch to machine frame. Position switch with jam nuts to allow correct clearance between switch and sensing plate. Jam nuts should be torqued from **162 to 198 in-lb (18.4 to 22.4 N-m)**. After jam nuts are tightened, make sure that clearance has not changed.

After adjustment to the down limit switch, use the InfoCenter Display (see Diagnostics Screen (PTO item) in the InfoCenter Display section of this chapter) to verify that down limit switch and circuit wiring **are** functioning correctly.

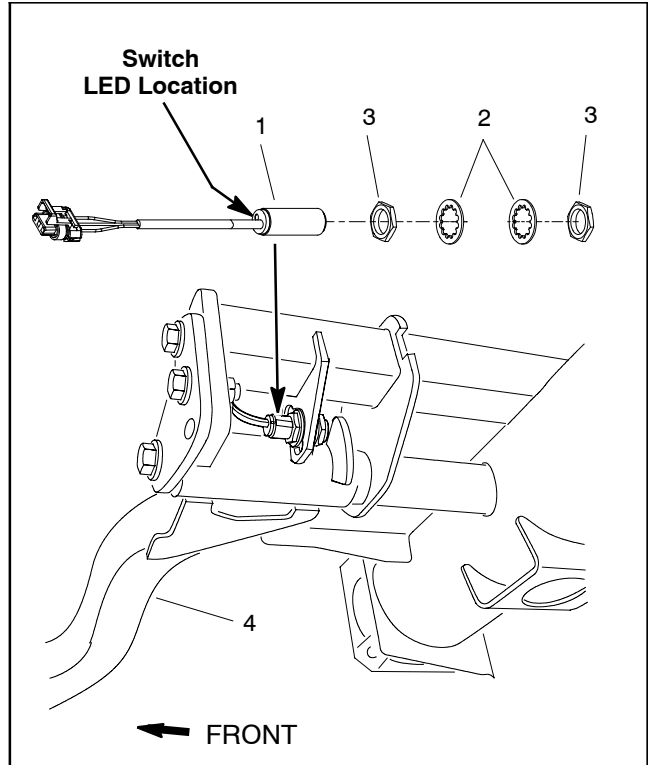


Figure 29

- | | |
|----------------------|-------------|
| 1. Down limit switch | 3. Jam nut |
| 2. Lock washer | 4. Lift arm |

Mow/Transport Switch

The mow/transport switch is a normally closed proximity switch that is attached to the bottom of the floor platform (Fig. 30).

When the mow stop lever is in the MOW position, the tab on the mow stop lever is positioned away from the target end of the mow/transport switch so the switch is closed. The tab on the mow stop lever is moved next to the mow/transport switch when the mow stop lever is in the TRANSPORT position causing the switch to open.

Adjustment

The distance between the mow/transport switch and the tab on the mow stop lever should be from **0.094" to 0.100" (2.4 to 2.5 mm)** when the mow stop lever is in the TRANSPORT position. If distance is incorrect, loosen jam nuts that secure brake switch to frame bracket. Position switch with jam nuts to allow correct clearance between switch and mow stop lever. Jam nuts should be torqued from **162 to 198 in-lb (18.4 to 22.4 N-m)**. After jam nuts are tightened, make sure that clearance has not changed and that mow stop lever does not contact switch as it is moved between positions.

After adjustment to the mow/transport switch, use the InfoCenter Display to verify that mow/transport switch and circuit wiring **are** functioning correctly (see Diagnostics Screen (Hi/Low Range item) in the InfoCenter Display section of this chapter).

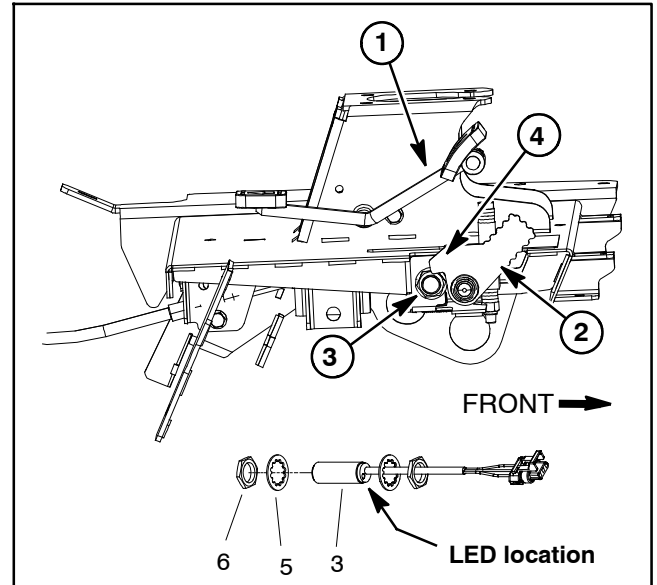


Figure 30

- | | |
|-------------------------|-------------------------|
| 1. Traction pedal | 4. Lever tab |
| 2. Mow stop lever | 5. Lock washer (2 used) |
| 3. Mow/transport switch | 6. Jam nut (2 used) |


Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before doing a continuity check of the switch).

NOTE: Electrical troubleshooting of any 12 volt power connection can be performed through voltage drop tests without disconnecting the component.

NOTE: Use the InfoCenter display to test TEC controller inputs and outputs before further troubleshooting of an electrical problem on your Reelmaster. Inputs and outputs can be tested using the InfoCenter Diagnostic menu (see InfoCenter Display in this chapter).

NOTE: See the Kubota Workshop Manual, Diesel Engine, 05- E4B Series for engine electrical component repair information.



CAUTION

When testing electrical components for continuity with a multimeter (ohms setting), make sure that power to the circuit has been disconnected.

Ignition Switch

The ignition (key) switch has three (3) positions (OFF, ON/PREHEAT and START). The switch is mounted on the control console. The Toro Electronic Controller (TEC) monitors the operation of the ignition switch.

Testing

NOTE: Before disconnecting the ignition switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see Diagnostics Screen (Engine Start item) in the InfoCenter Display section of this chapter). If the InfoCenter Display verifies that the ignition switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If the InfoCenter Display determines that the ignition switch and circuit wiring **are not** functioning correctly, proceed with ignition switch testing using the following steps.

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Remove outside control arm cover to gain access to ignition switch (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).
3. Disconnect wire harness connector from the ignition switch.
4. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each ignition switch position. The ignition switch terminals are marked as shown in Figure 31. The circuitry of this switch is shown in the chart below. Verify continuity between switch terminals.

POSITION	CIRCUIT
OFF	NONE
ON/PREHEAT	B + I + A, X + Y
START	B + I + S

5. Replace ignition switch if testing determines that the switch is faulty.
6. If ignition switch tests correctly and circuit problem still exists, check wire harness (see Electrical Schematic and Circuit Drawings in Chapter 9 - Foldout Drawings).
7. After ignition switch testing is complete, connect wire harness connector to the ignition switch. Install control arm cover to machine (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).

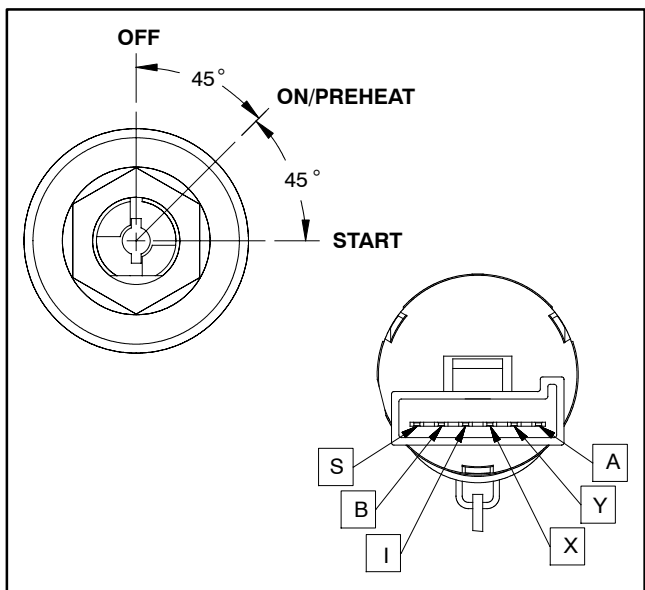


Figure 31

12 VDC System Fuses

The fuse block is located behind the control arm access cover (Fig. 32).

In addition to the 12 VDC fuses in the fuse block, a 2 Amp fuse is included in the wire harness to protect the logic power circuit for the TEC controller. This fuse resides in a fuse holder near the engine starter motor and is secured to the wire harness with a cable tie (Fig. 33).

Identification and Function

The fuses are held in the fuse block. Use Figure 34 to identify each individual fuse and its correct amperage. Fuses for your Reelmaster have the following function:

Left Fuse 1 (15 Amp): Protects main and starter circuit power supply.

Left Fuse 2 (10 Amp): Protects main power supply.

Left Fuse 3 (10 Amp): Protects power supply for headlights.

Left Fuse 4 (10 Amp): Protects power supply for power point.

Right Fuse 1 (7.5 Amp): Protects power supply for TEC controller outputs.

Right Fuse 2 (7.5 Amp): Protects power supply for TEC controller outputs.

Right Fuse 3 (7.5 Amp): Protects power supply for TEC controller outputs.

Right Fuse 4: Available for 20 Amp fuse used with optional power operator seat.

Fuse Testing

1. Make sure that ignition switch is in the OFF position and key is removed from ignition switch.
2. Remove control arm access cover to locate fuses.
3. Remove fuse(s) from the fuse block for testing. Fuse should have continuity between fuse terminals.
4. After fuse testing is completed, install control arm access cover.

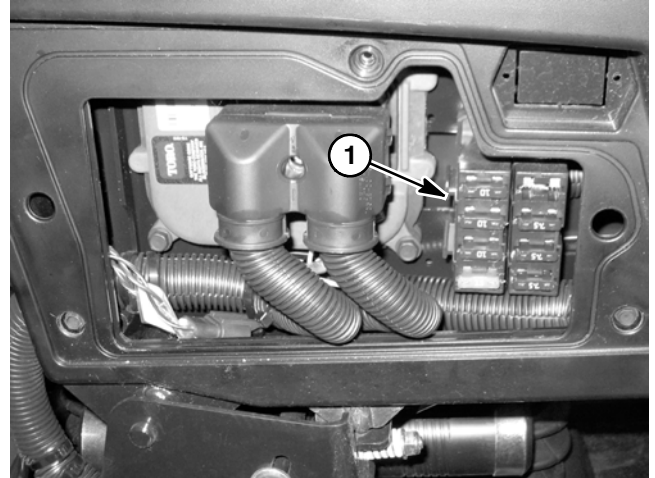


Figure 32
1. Fuse block

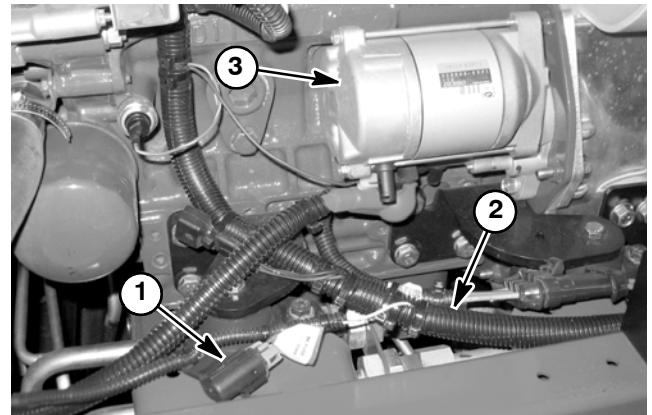


Figure 33

1. Fuse
2. Main wire harness
3. Starter motor

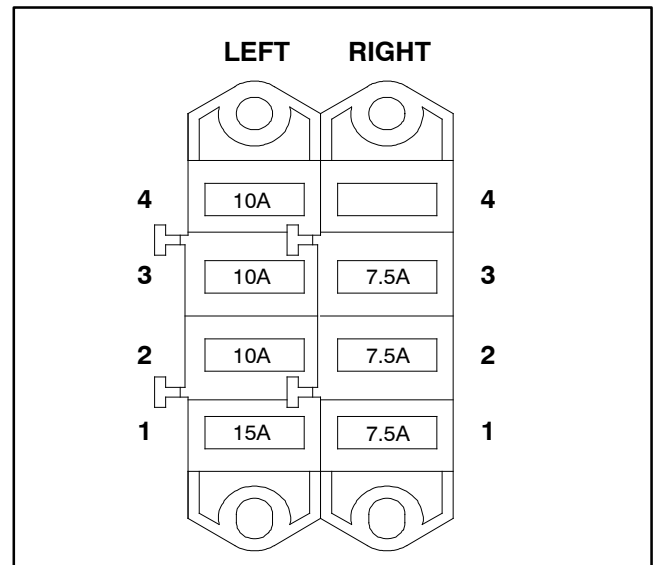


Figure 34

48 VDC System Fuses

Several fuses are used in the 48 VDC system (motor/generator and cutting unit motors) for circuit protection.

Fuse Identification and Function

35 Amp Reel Motor Fuses: Protect the 48 VDC power supply circuits for the electric reel motors. The reel motor fuses are located in a fuse holder behind the hood saddle under the hood (Fig. 35).

10 Amp Logic Relay Fuse: Protects the 48 VDC logic circuit for the motor/generator and main contactor. The logic relay fuse is located in an in-line fuse holder attached near the reel motor fuse holder (Fig. 35).

250 Amp Maxi Fuse: Protects main 48 VDC power supply. The 250 amp fuse is connected to the isolator terminal and the main contactor behind the 48 VDC battery disconnect attached to the right side frame rail (Fig. 36).

Fuse Testing

1. Make sure that ignition switch is in the OFF position and key is removed from ignition switch.
2. To prevent unexpected 48 VDC system component operation, unplug the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).
3. Locate and remove fuse(s) for testing. Fuse should have continuity between fuse terminals. Replace fuse if testing determines that it is faulty.
4. After fuse testing is completed, install removed covers and plug the 48 VDC battery disconnect into the socket.

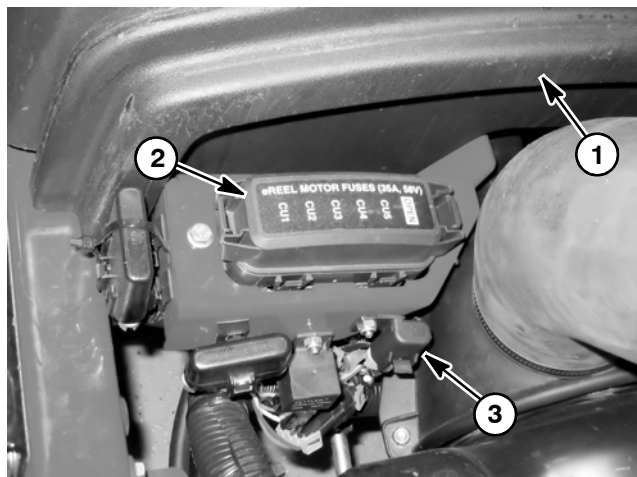


Figure 35

1. Hood saddle
2. Reel motor fuses
3. Logic relay fuse

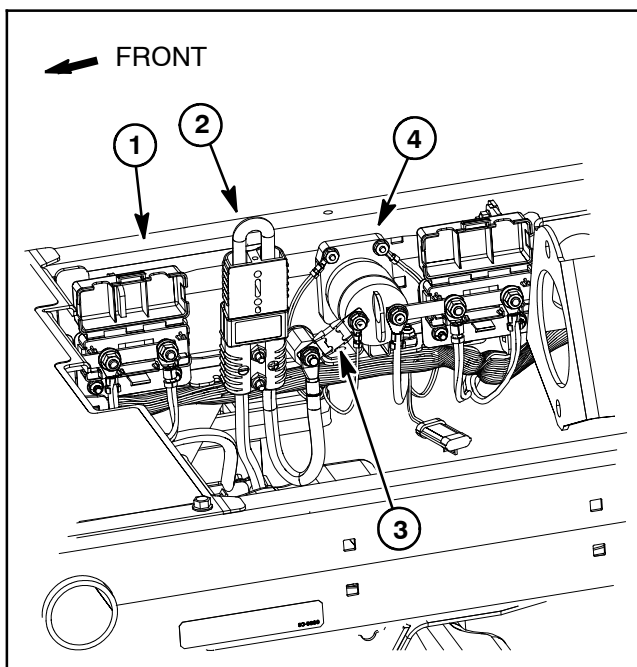


Figure 36

1. RH frame rail
2. 48V battery disconnect
3. 250A fuse
4. Main contactor

Engine Speed Switch

The engine speed switch is a momentary switch that is used as an input for the TEC controller to raise or lower the engine speed. When the switch is depressed and held in the forward position, the engine speed will increase. Conversely, when the rear of the switch is depressed, engine speed will decrease. The engine speed switch is located on the control arm (Fig. 37).

Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Disassemble control arm to gain access to engine speed switch (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).
3. Disconnect wire harness connector from the engine speed switch.
4. The speed switch terminals are marked as shown in Figure 38. The circuit logic of the switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals. Replace switch if testing identifies that switch is faulty.

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
FRONT OF SWITCH PRESSED	2 + 3 5 + 6	2 + 1 5 + 4
NEUTRAL	NONE	ALL
REAR OF SWITCH PRESSED	2 + 1 5 + 4	2 + 3 5 + 6

5. If speed switch tests correctly and circuit problem still exists, check circuit wire harness (see Electrical Schematic and Wire Harness Drawings in Chapter 9 - Foldout Drawings).
6. After testing is completed, connect wire harness connector to the switch.
7. Assemble control arm (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).

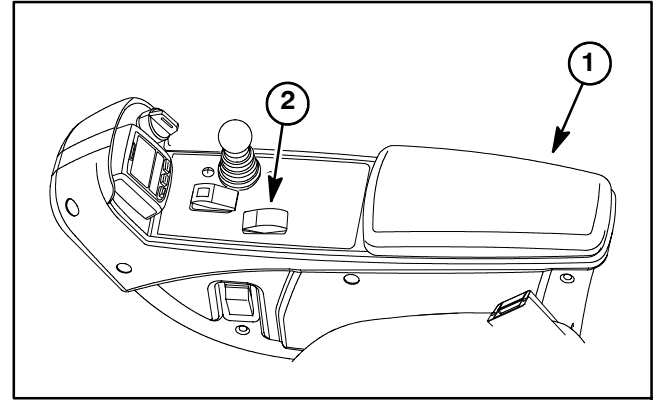
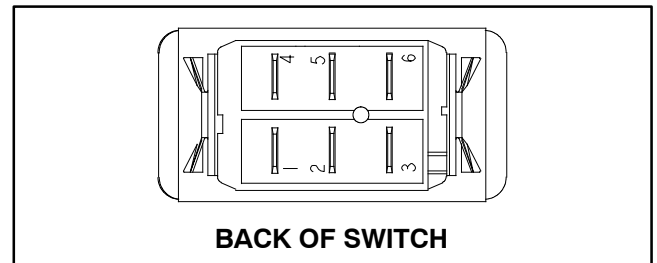


Figure 37

1. Console arm 2. Engine speed switch



BACK OF SWITCH

Figure 38

NOTE: Reel engine speed switch terminals 4, 5 and 6 are not used on Reelmaster 5010-H machines.

Reel Engage/Disengage Switch

The reel engage/disengage switch is used to allow the cutting units to operate. An indicator light on the switch identifies when the engage/disengage switch is engaged. The reel engage/disengage switch is mounted on the control panel (Fig. 39). The Toro Electronic Controller (TEC) monitors the operation of the reel engage/disengage switch.

NOTE: To raise or lower the cutting units, the operator seat has to be occupied. Also, to lower the cutting units, the traction speed has to be in LOW (mow) range.

Testing

NOTE: Before disconnecting the reel engage/disengage switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see Diagnostics Screen (PTO item) in the InfoCenter Display section of this chapter). If the InfoCenter Display verifies that the engage/disengage switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If the InfoCenter Display determines that the engage/disengage switch and circuit wiring **are not** functioning correctly, proceed with engage/disengage switch testing using the following steps.

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Remove control arm covers to gain access to engage/disengage switch (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).
3. Disconnect wire harness connector from the engage/disengage switch.
4. With the use of a multimeter (ohms setting), the switch functions can be tested to determine whether continuity exists between the various terminals for each switch position. The reel engage/disengage switch terminals are marked as shown in Figure 40. The circuitry of this switch is shown in the chart below. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
ON	2 + 3	5 + 6
OFF	2 + 1	5 + 4

5. Replace reel engage/disengage switch if testing determines that it is faulty.
6. If engage/disengage switch tests correctly and circuit problem still exists, check circuit wire harness (see Electrical Schematic and Circuit Drawings in Chapter 9 - Foldout Drawings).
7. After reel engage/disengage switch testing is completed, connect wire harness connector to the reel engage/disengage switch. Install control arm cover to machine (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).

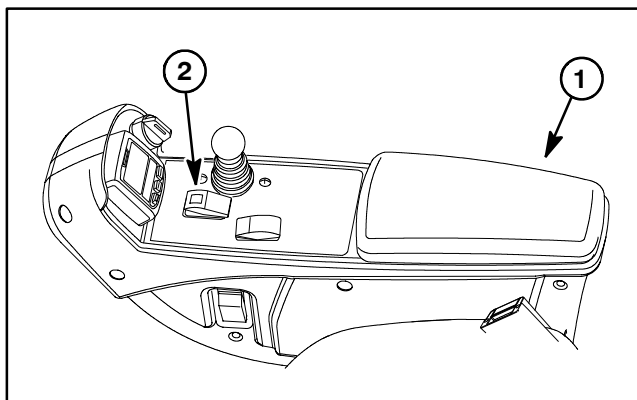
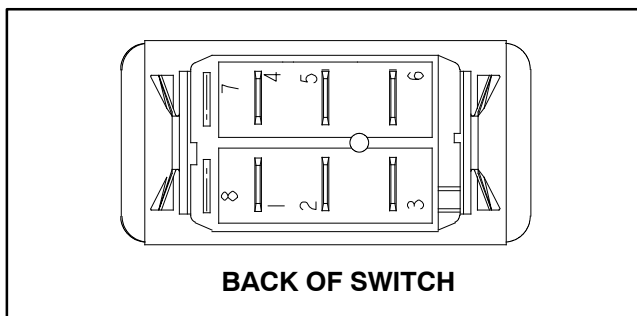


Figure 39

1. Console arm
2. Reel switch



BACK OF SWITCH

Figure 40

NOTE: Reel engage/disengage switch terminals 1 and 4 are not used on Reelmaster 5010- H machines.

Headlight Switch

The headlight switch allows the headlights to be turned on and off. This rocker switch is located on the operator side of the control arm (Fig. 41).

NOTE: The Toro Electronic Controller (TEC) **does not** monitor the operation of the headlight switch.

Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Remove inside control arm cover to gain access to headlight switch (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).
3. Disconnect wire harness connector from the headlight switch.
4. With the use of a multimeter (ohms setting), the headlight switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. The switch terminals are marked as shown in Figure 42. The circuitry of the headlight switch is shown in the chart below. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
ON	2 + 3	5 + 6
OFF	2 + 1	5 + 4

5. Replace headlight switch if testing determines that it is faulty.

6. When headlight switch testing is complete, connect wire harness connector to the switch. Install control arm cover to machine (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).

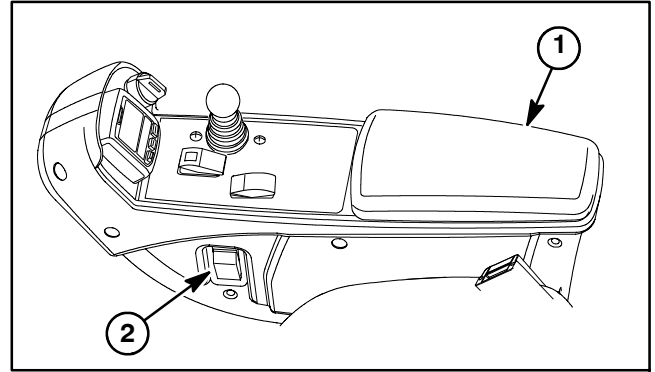
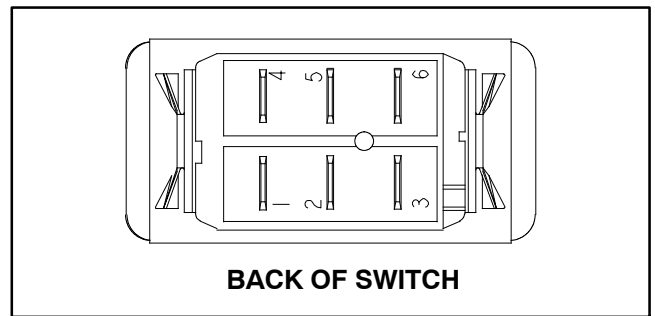


Figure 41

1. Console arm 2. Headlight switch



BACK OF SWITCH

Figure 42

NOTE: Headlight switch terminals 1, 4, 5 and 6 are not used on Reelmaster 5010- H machines.

Seat Switch

The seat switch is normally open and closes when the operator seat is occupied. If the traction system or reel engage/disengage switch is engaged when the operator raises out of the seat, the engine will stop. The seat switch is located directly under the operator seat. The Toro Electronic Controller (TEC) monitors the operation of the seat switch.

Testing

NOTE: Before disconnecting the seat switch for testing, the switch and its circuit wiring should be tested as a TEC input with the InfoCenter Display (see Diagnostics Screen (PTO item) in the InfoCenter Display section of this chapter). If the InfoCenter Display verifies that the seat switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If the InfoCenter Display determines that the seat switch and circuit wiring **are not** functioning correctly, proceed with seat switch testing using the following steps.

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Disconnect wire harness connector from the seat switch electrical lead near the manual tube under the operator seat (Fig. 43).
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
4. With no pressure on the seat, there **should be no continuity** between the seat switch terminals.
5. Press directly onto the seat switch through the seat cushion. There **should be continuity** between the seat switch terminals as the seat cushion approaches the bottom of its travel.
6. If testing determines that seat switch is faulty, replace switch (see Operator Seat in the Service and Repairs section of Chapter 6 - Chassis).
7. If the seat switch tests correctly and a circuit problem still exists, check circuit wire harness (see Electrical Schematic and Wire Harness Drawings in Chapter 9 - Foldout Drawings).
8. When seat switch testing is complete, connect wire harness connector to the seat switch electrical lead.

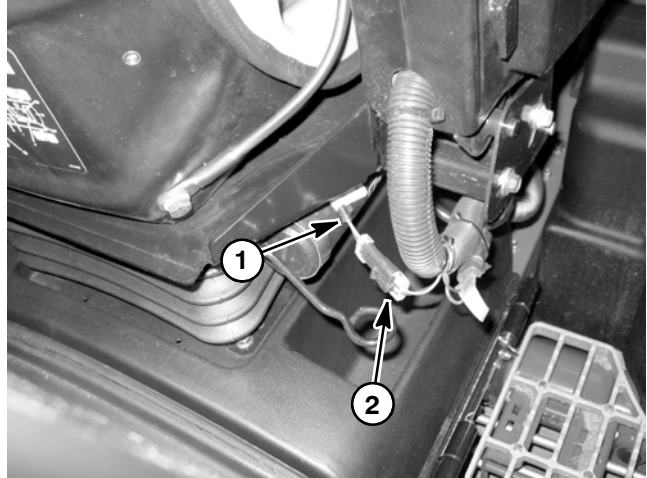


Figure 43

1. Seat switch lead
2. Electrical connector

Parking Brake Switch

The parking brake switch is a normally open proximity switch. The parking brake switch is attached to the bottom of the brake pedal (Fig. 44). The Toro Electronic Controller (TEC) monitors the operation of the parking brake switch.

When the parking brake is not applied, the parking brake detent is positioned near the target end of the parking brake switch so the switch is closed. The parking brake detent is moved away from the switch when the parking brake is applied causing the switch to open.

Testing

NOTE: Before disconnecting the parking brake switch for testing, the switch and its circuit wiring should be tested as a TEC controller input with the InfoCenter Display (see Diagnostics Screen (Backlap item) in the InfoCenter Display section of this chapter). If the InfoCenter Display verifies that the parking brake switch and circuit wiring **are** functioning correctly, no further brake switch testing is necessary. If the InfoCenter Display determines that the parking brake switch and circuit wiring **are not** functioning correctly, proceed with parking brake switch testing using the following steps.

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine.

2. Turn ignition switch to the ON/PREHEAT position (do not start engine) and check LED on cable end of parking brake switch.

A. Switch LED **should be** illuminated when the parking brake is released (brake not applied).

B. Switch LED **should not be** illuminated when the parking brake pedal is depressed (brake applied).

3. If the parking brake switch LED did not function correctly:

A. Make sure that parking brake switch is properly adjusted (see Parking Brake Switch in the Adjustments section of this chapter). If necessary, adjust switch and return to step 2 above.

B. Make sure ignition switch is OFF and disconnect the parking brake switch connector from the machine wire harness.

C. Using a multimeter, verify that the machine wire harness connector terminal for black wire is closed (continuity) to ground.

D. Turn ignition switch to the ON/PREHEAT position (do not start engine) and verify with a multimeter that machine wire harness connector terminal for parking brake switch pink wire has system voltage (12 VDC) present.

E. Turn ignition switch to the OFF position.

F. If black wire is closed to ground, pink wire has system voltage present and switch LED did not function, replace parking brake switch. Adjust switch during installation (see Parking Brake Switch in the Adjustments section of this chapter).

4. If the parking brake switch tests correctly and a circuit problem still exists, check circuit wire harness (see Electrical Schematic and Wire Harness Drawings in Chapter 9 - Foldout Drawings).

5. Make sure that wire harness electrical connector is connected to the parking brake switch.

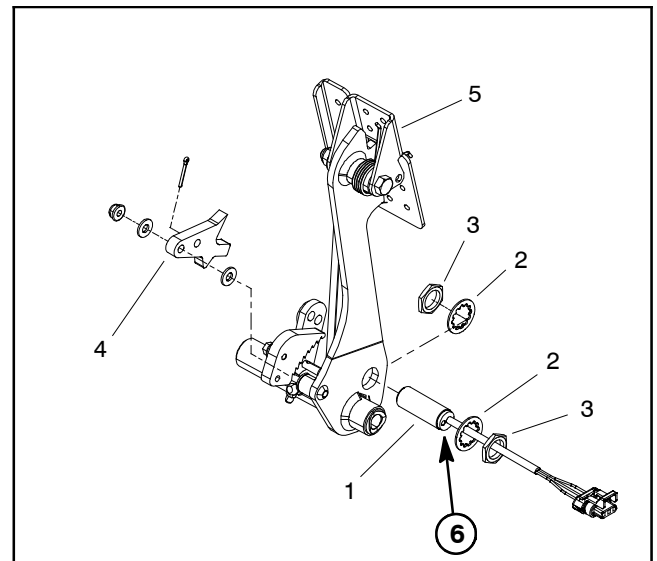


Figure 44

- | | |
|-------------------------|-------------------------|
| 1. Parking brake switch | 4. Parking brake detent |
| 2. Lock washer (2 used) | 5. Brake pedal |
| 3. Jam nut (2 used) | 6. Switch LED location |

Traction Neutral Switch

The traction neutral switch is a normally open proximity switch that closes when the traction pedal is in the neutral position. The switch mounts to the pump plate on the piston (traction) pump. The sensing element for the traction neutral switch is the traction pump lever that is secured to the pump control arm (Fig. 45). The Toro Electronic Controller (TEC) monitors the operation of the traction neutral switch.

Testing

NOTE: Before disconnecting the traction neutral switch for testing, the switch and its circuit wiring should be tested as a TEC controller input with the InfoCenter Display (see Diagnostics Screen (Engine Start item) in the InfoCenter Display section of this chapter). If the InfoCenter Display verifies that the traction neutral switch and circuit wiring **are** functioning correctly, no further neutral switch testing is necessary. If the InfoCenter Display determines that the traction neutral switch and circuit wiring **are not** functioning correctly, proceed with neutral switch testing using the following steps.

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine.
2. Tilt operator seat to gain access to traction neutral switch.
3. Turn ignition switch to the ON/PREHEAT position (do not start engine) and check LED on cable end of traction neutral switch.
 - A. Switch LED **should be** illuminated when the traction pedal is in the neutral position.
 - B. Switch LED **should not be** illuminated when the traction pedal is in either the forward or reverse position.
4. If the neutral switch LED did not function correctly:
 - A. Make sure that traction neutral switch is properly adjusted (see Traction Neutral Switch in the Adjustments section of this chapter). If necessary, adjust switch and return to step 3 above.
 - B. Make sure ignition switch is OFF and disconnect the traction neutral switch connector from the machine wire harness.

C. Using a multimeter, verify that the machine wire harness connector terminal for black wire is closed (continuity) to ground.

D. Turn ignition switch to the ON/PREHEAT position (do not start engine) and verify with a multimeter that machine wire harness connector terminal for neutral switch pink wire has system voltage (12 VDC) present.

E. Turn ignition switch to the OFF position.

F. If black wire is closed to ground, pink wire has system voltage present and switch LED did not function, replace traction neutral switch. Adjust switch during installation (see Traction Neutral Switch in the Adjustments section of this chapter).

5. If the traction neutral switch tests correctly and a circuit problem still exists, check circuit wire harness (see Electrical Schematic and Wire Harness Drawings in Chapter 9 - Foldout Drawings).

6. Make sure that wire harness electrical connector is connected to the traction neutral switch. Lower operator seat.

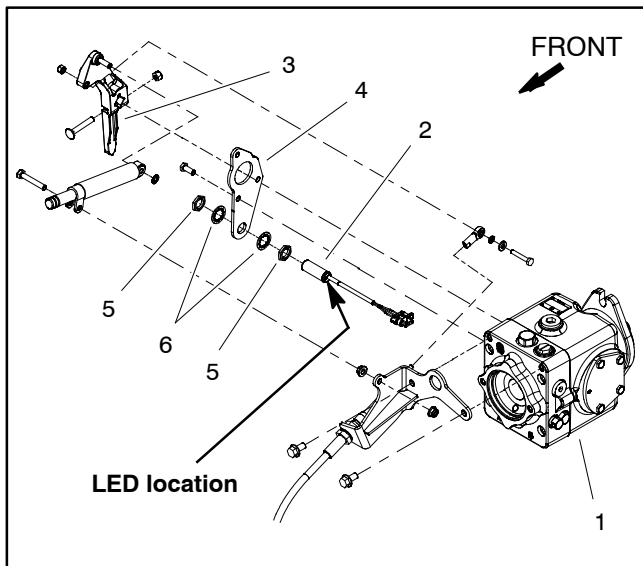


Figure 45

- | | |
|----------------------------|-------------------------|
| 1. Piston (traction) pump | 4. Pump plate |
| 2. Traction neutral switch | 5. Jam nut (2 used) |
| 3. Traction pump lever | 6. Lock washer (2 used) |

Cutting Unit Down Limit Switch

The cutting unit down limit switch is a normally open proximity switch that closes when the front, outside cutting units are in the turn-around position. The down limit switch is attached to a frame bracket inside the front, right lift arm pivot tube. A bracket on the front, right lift arm acts as the sensing plate for the down limit switch (Fig. 46). The Toro Electronic Controller (TEC) monitors the operation of the cutting unit down limit switch.

Testing

NOTE: Before disconnecting the cutting unit down limit switch for testing, the switch and its circuit wiring should be tested as a TEC controller input with the InfoCenter Display (see Diagnostics Screen (Backlap item) in the InfoCenter Display section of this chapter). If the InfoCenter Display verifies that the down limit switch and circuit wiring **are** functioning correctly, no further down limit switch testing is necessary. If the InfoCenter Display determines that the down limit switch and circuit wiring **are not** functioning correctly, proceed with down limit switch testing using the following steps.

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine.

2. Test cutting unit down limit switch as follows:

A. Turn ignition switch to the ON position (do not start engine) and check LED on cable end of down limit switch.

B. LED **should be** illuminated when the cutting units are lowered. LED **should not be** illuminated when the cutting units are raised to the turn around position.

3. If the cutting unit down limit switch LED did not function correctly:

A. Make sure that down limit switch is properly adjusted (see Cutting Unit Down Limit Switch in the Adjustments section of this chapter). If necessary, adjust switch and return to step 2 above.

B. Make sure ignition switch is OFF and disconnect the down limit switch connector from the machine wire harness.

C. Using a multimeter, verify that the machine wire harness connector terminal for black wire is closed (continuity) to ground.

D. Turn ignition switch to the ON/PREHEAT position (do not start engine) and verify with a multimeter that machine wire harness connector terminal for down limit switch pink wire has system voltage (12 VDC) present.

E. Turn ignition switch to the OFF position.

F. If black wire is closed to ground, pink wire has system voltage present and switch LED did not function, replace cutting unit down limit switch. Adjust switch during installation (see Cutting Unit Down Limit Switch in the Adjustments section of this chapter).

4. If the down limit switch tests correctly and a circuit problem still exists, check circuit wire harness (see Electrical Schematic and Wire Harness Drawings in Chapter 9 - Foldout Drawings).

5. Make sure that wire harness electrical connector is connected to the down limit switch after testing.

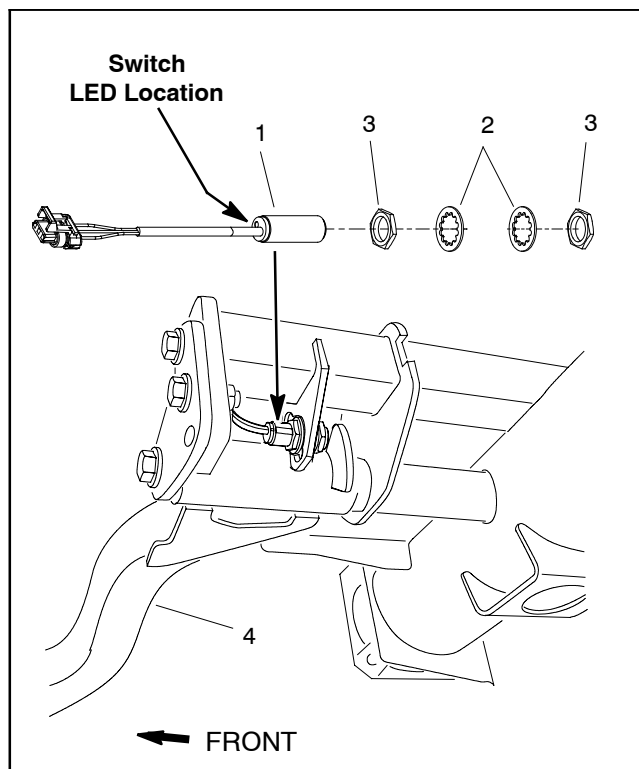


Figure 46

- | | |
|----------------------|-------------|
| 1. Down limit switch | 3. Jam nut |
| 2. Lock washer | 4. Lift arm |

Joystick Raise and Lower Switches

Two (2) micro switches for the joystick are located on the lower mow/raise lever that is attached to the control arm. The rear switch on the control is used to lower (and engage) the cutting units and the front switch to raise (and disengage) them. A normally open contact in the switch closes when the joystick is positioned to either lower or raise the cutting units. Each switch has an electrical connector to make sure the normally closed contact on the switch is not used. The raise switch has pink/blue and black harness wires connected to it and the lower switch has orange/white and black harness wires connected to it. The Toro Electronic Controller (TEC) monitors the operation of the joystick switches.

NOTE: To raise or lower the deck sections, the operator seat has to be occupied. Also, to lower the cutting deck sections, the traction speed has to be in LOW (mow) range.

Testing

NOTE: Before disconnecting the joystick switches for testing, the switches and their circuit wiring should be tested as a TEC controller input with the InfoCenter Display (see Diagnostics Screen (Cutting Units item) in the InfoCenter Display in this chapter). If the InfoCenter Display verifies that the joystick switches and circuit wiring **are** functioning correctly, no further switch testing is necessary. If the InfoCenter Display determines that either joystick switch and circuit wiring **are not** functioning correctly, proceed with testing procedure

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Remove control arm covers to gain access to joystick switches (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).
3. Disconnect wire harness electrical connector from the raise or lower switch that is to be tested (Fig. 47).
4. Connect a multimeter (ohms setting) across the normally open (NO) and common terminals of the switch (Fig. 48).
5. With the joystick in the neutral (center) position, there should be no continuity across the switch terminals.

6. Move and hold the joystick to activate the switch being tested. There should be continuity across the switch terminals.

7. If testing determines that joystick switch is faulty, replace switch.

8. If the joystick switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematic and Circuit Drawings in Chapter 9 - Foldout Drawings).

9. After switch testing is completed, connect wire harness electrical connector to the joystick switch.

10. Install control arm covers to machine (see Control Arm in the Service and Repairs section of Chapter 6 - Chassis).

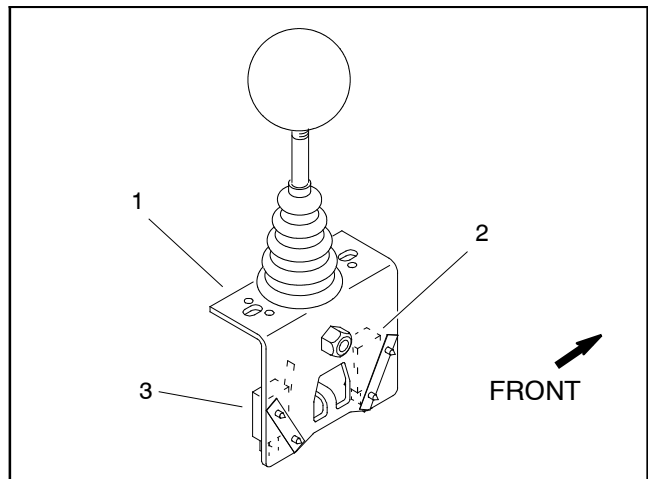


Figure 47

- | | |
|--------------------------|-----------------|
| 1. Lower mow/raise lever | 3. Lower switch |
| 2. Raise switch | |

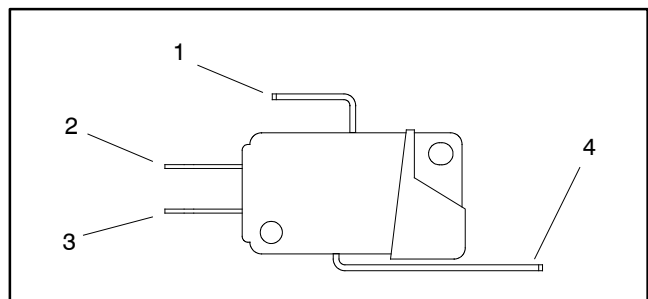


Figure 48

- | | |
|--------------------|-----------------|
| 1. Common terminal | 3. NC terminal |
| 2. NO terminal | 4. Switch lever |

Mow/Transport Switch

The mow/transport switch is a normally closed proximity switch that opens when the mow stop lever is placed in the transport position. The sensing plate for the mow/transport switch is the mow stop lever (Fig. 49). The Toro Electronic Controller (TEC) monitors the operation of the mow/transport switch.

Testing

NOTE: Before disconnecting the mow/transport switch for testing, the switch and its circuit wiring should be tested as a TEC controller input with the InfoCenter Display (see Diagnostics Screen (Hi/Low Range item) in the InfoCenter Display section of this chapter). If the InfoCenter Display verifies that the mow/transport switch and circuit wiring **are** functioning correctly, no further mow/transport switch testing is necessary. If the InfoCenter Display determines that the mow/transport switch and circuit wiring **are not** functioning correctly, proceed with mow/transport switch testing using the following steps.

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine.

2. Test mow/transport switch as follows:

A. Turn ignition switch to the ON position (do not start engine) and check LED on cable end of mow/transport switch.

B. LED **should be** illuminated when the mow stop lever is in the mow position. LED **should not be** illuminated when the mow stop lever is in the transport position.

3. If the mow/transport switch LED did not function correctly:

A. Make sure that mow/transport switch is properly adjusted (see Mow/Transport Switch in the Adjustments section of this chapter). If necessary, adjust switch and return to step 2 above.

B. Make sure ignition switch is OFF and disconnect the mow/transport switch connector from the machine wire harness.

C. Using a multimeter, verify that the machine wire harness connector terminal for black wire is closed (continuity) to ground.

D. Turn ignition switch to the ON/PREHEAT position (do not start engine) and verify with a multimeter that machine wire harness connector terminal for mow/transport switch pink wire has system voltage (12 VDC) present.

E. Turn ignition switch to the OFF position.

F. If black wire is closed to ground, pink wire has system voltage present and switch LED did not function, replace mow/transport switch. Adjust switch during installation (see Mow/Transport Switch in the Adjustments section of this chapter).

4. If the mow/transport switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematic and Wire Harness Drawings in Chapter 9 - Foldout Drawings).

5. Make sure that wire harness electrical connector is connected to the mow/transport switch after testing.

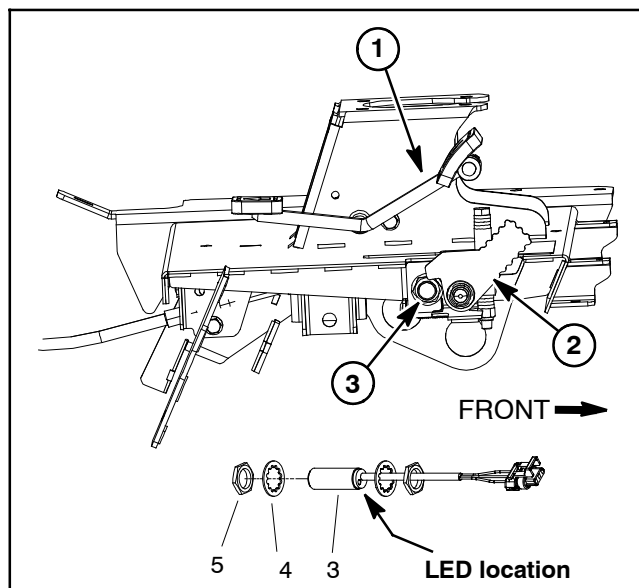


Figure 49

- | | |
|-------------------------|-------------------------|
| 1. Traction pedal | 4. Lock washer (2 used) |
| 2. Mow stop lever | 5. Jam nut (2 used) |
| 3. Mow/transport switch | |

Main Power, Glow and 48 VDC Logic Relays

Your Reelmaster uses three (3) identical electrical relays that have four (4) terminals. The main power and glow relays are attached to a frame bracket under the hood near the engine exhaust muffler (Fig. 50). The 48 VDC logic relay is attached to a frame bracket under the hood behind the reel motor fuse block (Fig. 51). A tag near the relay harness connector identifies each relay.

The main power relay is used to provide current to the TEC controller, headlights, power point and optional electric equipment. When the ignition switch is in the ON/PREHEAT or START position, the main power relay is energized. A fault code will be displayed on the InfoCenter Display if the main power relay or circuit wiring is faulty.

The glow relay is used to provide current to the engine glow plugs when energized by the TEC controller. The TEC controls and monitors the operation of the glow relay. The glow relay and its circuit wiring **should** be tested as a TEC output with the InfoCenter Display before disconnecting and testing the relay (see InfoCenter Display in this chapter). A fault code may be displayed on the InfoCenter Display if the glow relay or circuit wiring is faulty.

The 48 VDC logic relay is used to provide 48 VDC logic power to the motor/generator and reel motor controllers. It also supplies power to the main contactor in the electric reel circuit. This relay is energized by an output from the TEC controller.

Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.

2. Open hood to gain access to relays.

3. Locate relay and disconnect the machine wire harness connector from the relay. If main power or glow relay are to be removed, remove hood saddle from machine for easier access to start relay. Remove relay from machine for easier testing.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

4. Verify coil resistance between terminals 85 and 86 with a multimeter (ohms setting) (Fig. 52). Resistance should be approximately **72 ohms**.

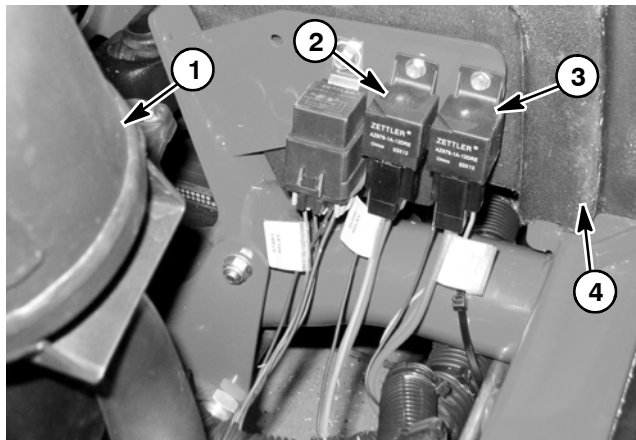


Figure 50

- | | |
|---------------------|----------------|
| 1. Exhaust muffler | 3. Glow relay |
| 2. Main power relay | 4. Hood saddle |

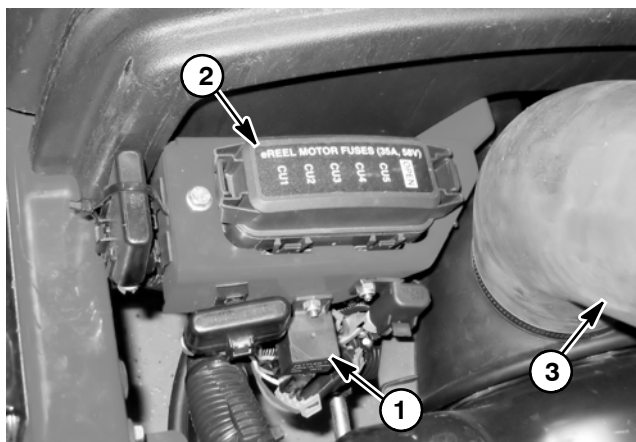


Figure 51

- | | |
|-----------------------|-------------------------|
| 1. 48 VDC logic relay | 3. Generator air intake |
| 2. Reel motor fuses | |

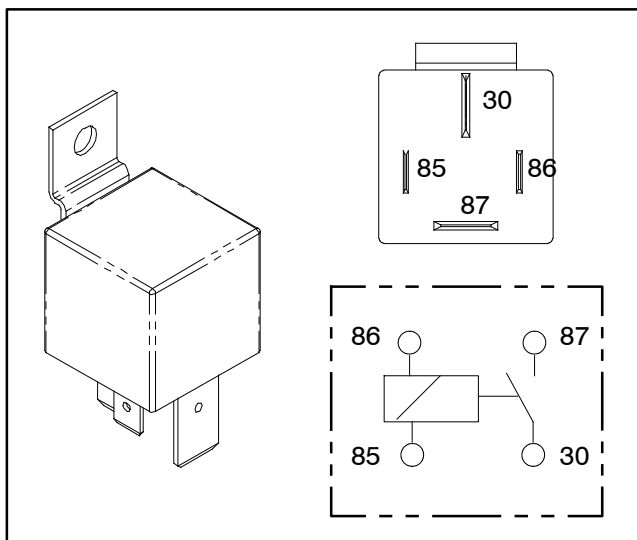


Figure 52

5. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should have continuity between terminals 30 and 87 as +12 VDC is applied to terminal 85. The relay should not have continuity between terminals 30 and 87 as +12 VDC is removed from terminal 85.

6. When relay testing is complete, disconnect voltage and multimeter leads from the relay terminals.

7. Replace relay if testing determines that it is faulty.

8. Secure relay to machine and connect machine wire harness connector to relay. Install hood saddle to machine if it was removed. Lower and secure hood.

Start Relay

The start relay is used in the engine starting circuit. When energized by the TEC controller, the start relay provides a current path to energize the engine starter solenoid. The start relay has five (5) terminals and is attached to a frame bracket under the hood near the engine exhaust muffler (Fig. 53). Relays can be identified by a tag on the wire harness.

Testing

NOTE: The start relay **should** be tested as a TEC controller output with the InfoCenter Display before disconnecting and testing the relay (see Diagnostics Screen (Engine Start item) in the InfoCenter Display section of this chapter). The InfoCenter Display will identify if the TEC output to the start relay exists when machine controls are in the correct position. If the TEC controller output exists for the start relay but the relay is not functioning correctly, suspect a failed start relay or an open in the start relay circuit.

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Open hood to gain access to start relay. Remove hood saddle from machine for easier access to start relay.
3. Locate start relay and disconnect the machine wire harness connector from the relay. Remove relay from machine for easier testing.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

4. Using a multimeter (ohms setting), measure coil resistance between terminals 85 and 86 (Fig. 54). Resistance should be between **70 and 90 ohms**.
5. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should have continuity between terminals 30 and 87 as +12 VDC is applied to terminal 85. The relay should not have continuity between terminals 30 and 87 as +12 VDC is removed from terminal 85.

6. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.

7. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should not have continuity between terminals 30 and 87A as +12 VDC is applied to terminal 85. The relay should have continuity between terminals 30 and 87A as +12 VDC is removed from terminal 85.

8. When testing is complete, disconnect voltage and multimeter leads from the relay terminals.

9. Replace start relay if testing determines that it is faulty.

10. Secure start relay to machine and connect machine wire harness connector to relay. Install hood saddle to machine. Lower and secure hood.

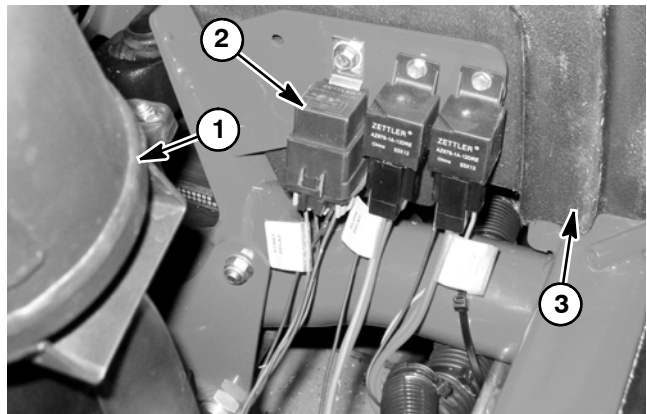


Figure 53

1. Exhaust muffler
2. Start relay
3. Hood saddle

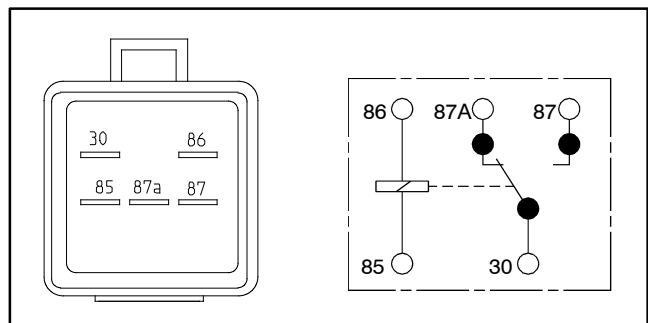


Figure 54

Main Contactor

The main contactor provides current to the 48 VDC system circuits (e.g. motor/generator, reel motors). When the ignition switch is ON, the 48 VDC logic relay is energized by the TEC controller which allows the main contactor to be energized if allowed by the motor/generator controller. The main contactor is attached to the right side frame rail under the operator seat (Fig. 55).

NOTE: If electrical problems exist with the main contactor, a fault may have occurred that would be indicated by a fault code on the InfoCenter Display. Before considering that main contactor service work is necessary, check for any existing fault codes that indicate problems with the contactor.

Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Raise operator seat to access main contactor.
3. Separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect. (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected 48 VDC system component operation.
4. Remove cover from main contactor (not shown).
5. Disconnect all wire harness electrical connections from contactor. Note wire connector locations on contactor for reassembly purposes.
6. Using jumper wires, apply 48 VDC directly across the contactor coil posts (Fig. 56). The contactor should click as the coil is energized. With the contactor coil energized, resistance across the main contact posts should be less than **1 ohm**.
7. Remove voltage from contactor coil posts. The contactor should click as the coil is de-energized. With the contactor coil not energized, resistance across the main contact posts should be **infinite ohms**.
8. With no voltage applied to contactor posts, measure resistance across the contactor coil posts (Fig. 56). The resistance should be approximately **126 ohms**.
9. Replace main contactor if testing determines that it is faulty.

10. Connect electrical connections to main contactor (Fig. 56). Torque nuts that secure connections to contactor main contact posts from **40 to 50 in-lb (4.6 to 5.6 N-m)** and nuts that secure connections to contactor coil posts to **20 in-lb (2.2 N-m)**.

11. Plug the 48 VDC battery disconnect back into the socket. Lower and secure operator seat.

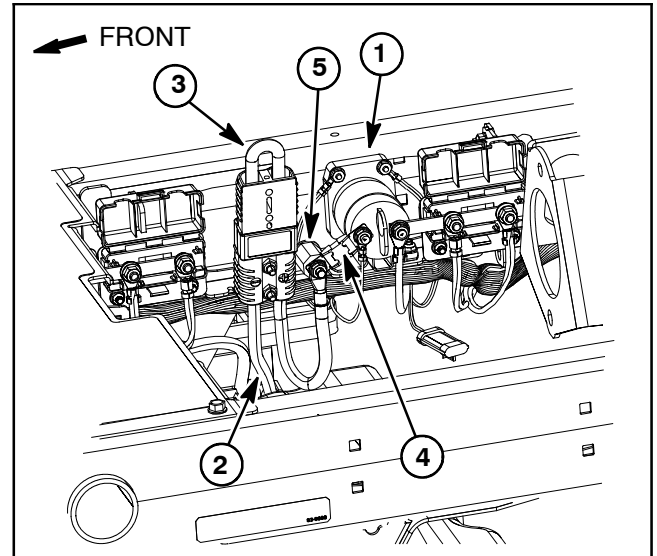


Figure 55

- | | |
|---------------------------|----------------------|
| 1. Main contactor | 4. Fuse (250A / 58V) |
| 2. Positive battery cable | 5. Isolator |
| 3. 48V battery disconnect | |

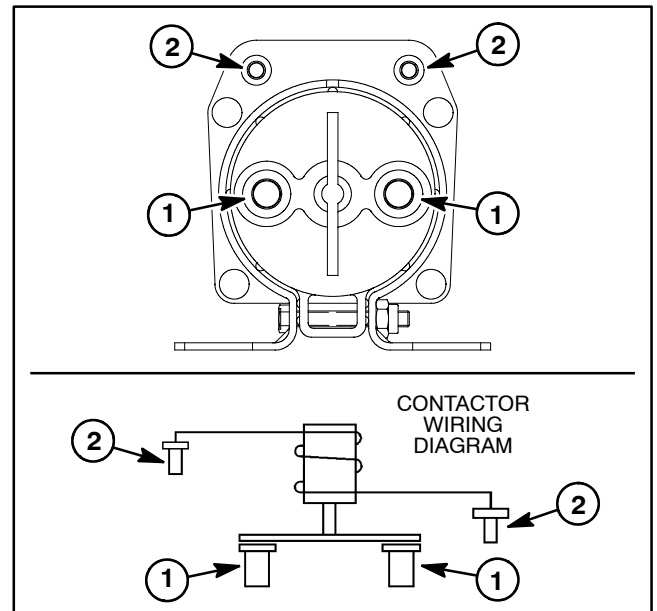


Figure 56

- | | |
|-----------------------|-------------------------|
| 1. Main contact posts | 2. Contactor coil posts |
|-----------------------|-------------------------|

Toro Electronic Controller (TEC)

Reelmaster 5010-H machines use a Toro Electronic Controller (TEC) to control electrical system operation. The TEC controller senses the condition of various switches (inputs) and directs power output to allow certain machine functions. The TEC is attached to the control arm behind the access panel on the outside of the control arm (Fig. 57).

Logic power is provided to the controller as long as the battery cables are connected to the battery. A 2 Amp fuse (fuse F4) provides circuit protection for this logic power to the controller.

Inputs from the ignition, neutral, parking brake, reel engage/disengage, seat, mow/transport, joystick lower/raise, reels down limit, engine speed, engine temperature sender and engine oil pressure switches are all monitored by the TEC controller.

Current output to the lift circuit hydraulic valve solenoid coils, engine components (glow plug relay, start relay, fuel pump and fuel actuator) and reel circuit 48 VDC logic relay are controlled based on the inputs received by the TEC controller. Circuit protection for TEC outputs is provided by three (3) 7.5 Amp fuses (fuse locations F2-1, F2-2 and F2-3).

The InfoCenter Display should be used when checking inputs and outputs of the TEC used on your Reelmaster. If the TEC detects a malfunction in any of the controlled circuits, the InfoCenter Display can also be used to identify the fault (see InfoCenter Display in this chapter).

The diagram in Figure 58 depicts the connection terminal functions for the TEC controller. Note that electrical power for controller outputs is provided through three (3) connections (PWR 2, PWR 3 and PWR 4) each protected with a 7.5 amp fuse. A fifty (50) pin wire harness connector attaches to the controller. The connector pins are identified in the diagram in Figure 58. The layout of the wire harness connector that plugs into the TEC controller is shown in Fig. 59.

IMPORTANT: When testing for wire harness continuity at the connector for the TEC controller, take care to not damage the connector pins with multi-meter test leads. If connector pins are enlarged or damaged during testing, connector repair will be necessary for proper machine operation.

The machine electrical schematic and wire harness drawings in Chapter 10 - Foldout Drawings can be used to identify possible circuit problems between the controller and the input/output devices (e.g. switches and solenoid coils).

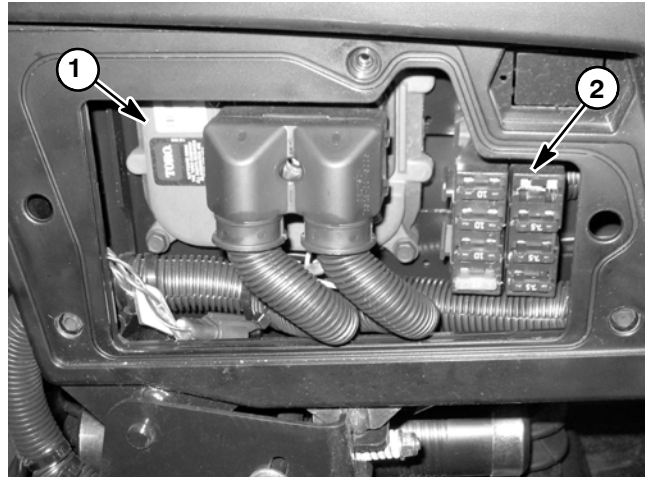


Figure 57

- 1. TEC controller
- 2. Fuse block

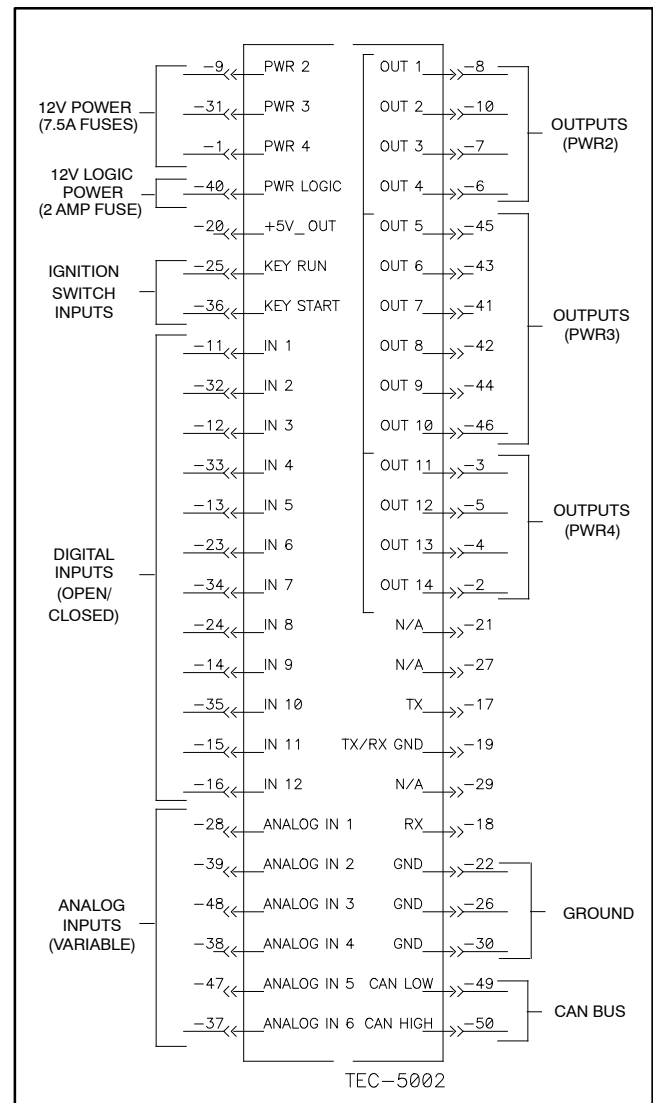


Figure 58

Because of the solid state circuitry built into the TEC controller, there is no method to test it directly. The TEC may be damaged if an attempt is made to test it with an electrical test device, such as a digital multimeter.

IMPORTANT: Before performing welding on the machine, disconnect both positive and negative battery cables from the battery, disconnect both wire harness connectors from the TEC controller and disconnect the terminal connector from the alternator to prevent damage to the electrical system.

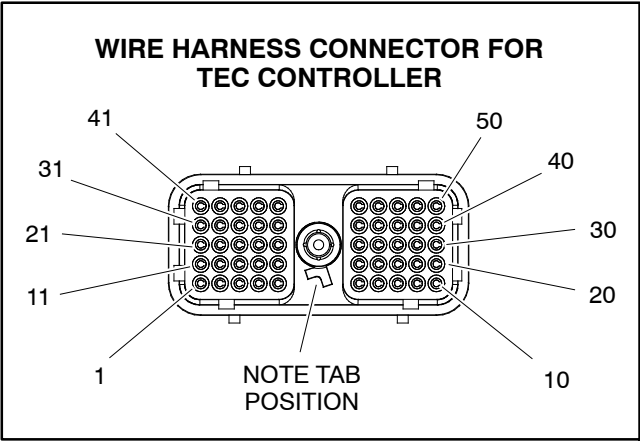


Figure 59

Fusible Link Harness

The Reelmaster 5010- H uses three (3) fusible links for circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the main wire harness (Fig. 60). If any of these links should fail, current to the protected circuit will cease. Refer to wire harness drawings in Chapter 9 - Foldout Drawings for additional fusible link information.

Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Disconnect negative battery cable from battery at rear of machine. Then disconnect positive cable from battery (see Battery Service in the Service and Repairs section of this chapter).
3. Locate and unplug fusible link connector P1 from platform wire harness.
4. Use a multimeter to make sure that continuity exists between each terminal pin in connector P1 and connector J1 at the starter (Fig. 61). If any of the fusible links are open, replace the fusible link harness.
5. After testing is complete, make sure that fusible link harness connectors are securely attached to starter and machine wire harness.
6. Connect positive battery cable to battery terminal first and then connect negative cable to battery.

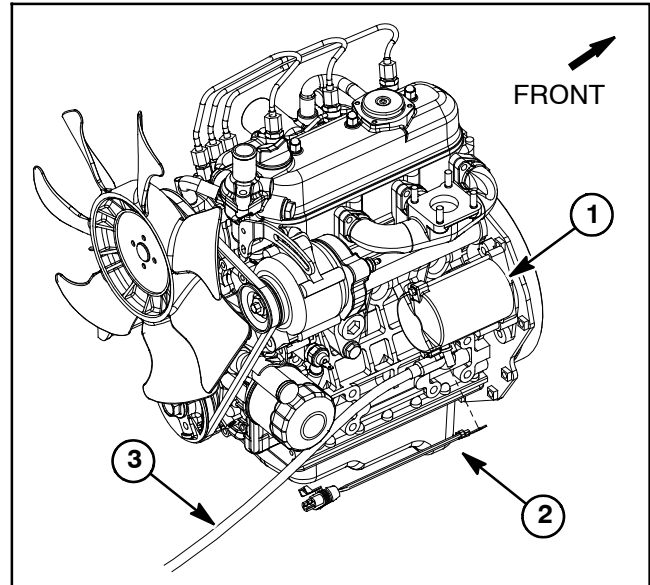


Figure 60

1. Starter motor
2. Fusible link harness
3. Positive battery cable

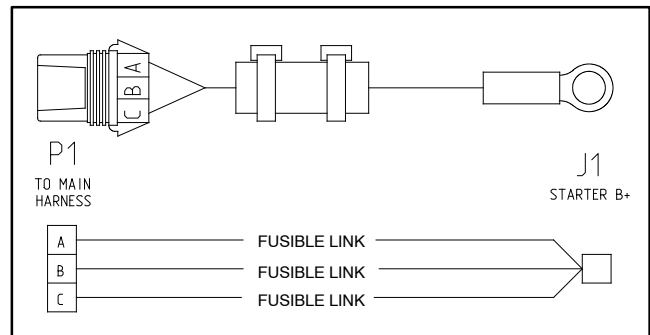


Figure 61

Diode Assembly

A diode assembly is used in the Reelmaster main wire harness (Fig. 62). The diode is used for circuit protection from voltage spikes that occur when the starter solenoid is de-energized.

Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Locate diode assembly near alternator on engine and remove cable tie that secures diode to wire harness. Unplug the diode from the wire harness for testing.
3. The diode (Fig. 63) can be tested using a digital multimeter (diode test or ohms setting) and the table below.

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

4. If testing determines that diode is faulty, replace diode assembly.
5. After diode testing is complete, make sure that diode is fully installed into wire harness connector and secured to harness with cable tie.

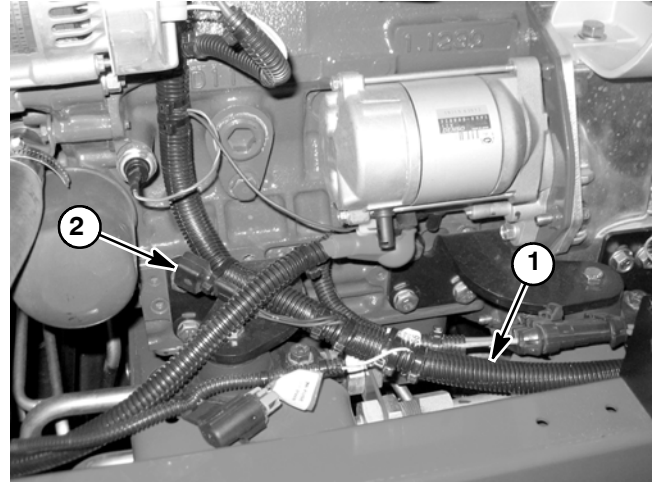


Figure 62

1. Main wire harness
2. Diode assembly

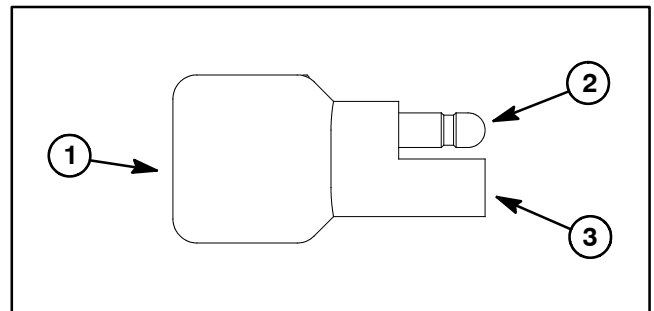


Figure 63

1. Diode
2. Male terminal
3. Female terminal

48 VDC System Protection Diode

The Reelmaster 5010-H 48 VDC system includes a diode that is used for circuit protection from voltage spikes when the main contactor is de-energized. The diode plugs into the main wire harness near the 48 VDC battery disconnect and main contactor under the operator seat (Fig. 64).

Protection Diode Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Raise operator seat.
3. Separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect. (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected 48 VDC system component operation.
4. Locate protection diode near 48 VDC battery disconnect and unplug the diode from the wire harness for testing.
5. The protection diode (Fig. 65) can be tested using a digital multimeter (diode test or ohms setting) and the table to the right. Replace the protection diode if testing determines that it is faulty.

NOTE: Protection diode terminals 2, 3, 4 and 5 are not used on Reelmaster 5010-H machines.

6. After testing is complete, make sure that protection diode is fully installed into wire harness connector.
7. Plug the 48 VDC battery disconnect back into the socket. Lower and secure operator seat.

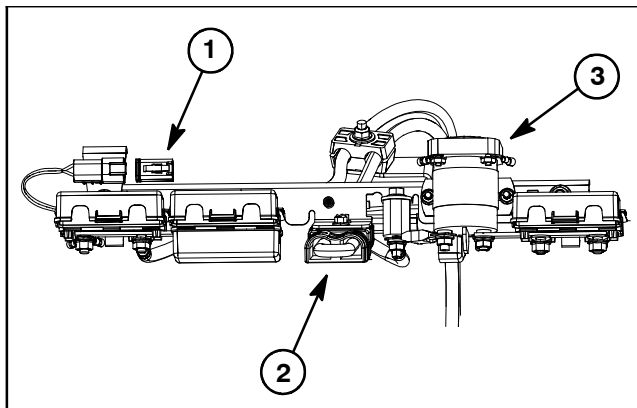


Figure 64

- | | |
|---------------------------|-------------------|
| 1. Protection diode | 3. Main contactor |
| 2. 48V battery disconnect | |

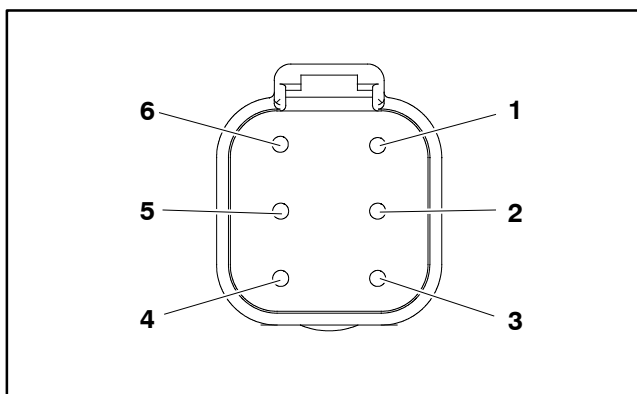


Figure 65

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
6	1	YES
1	6	NO

Location ID Module

The location ID module exists in the 48 VDC electrical circuit to identify the location of the five (5) cutting reel motors. This module allows such machine features as starting and stopping the rear cutting units slightly later than the front cutting units. The location module plugs into the main wire harness near the 48 VDC fuse block (Fig. 66).

NOTE: If electrical problems exist with the location ID module, a fault may have occurred that would be indicated by a fault code on the InfoCenter Display. Before considering that location ID module service work is necessary, check for any existing fault codes that indicate problems with the module.

Testing

1. Park machine on level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.
2. Raise and support operator seat and hood.
3. Separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected cutting unit operation.
4. Locate location ID module secured to the frame near the 48 VDC fuse block (Fig. 66).
5. Carefully unplug main wire harness connector from location ID module connector.
6. Using a multimeter, measure resistances between module connector terminals as follows (Fig. 67):

Connector Terminals	Resistance
A and F	15 K ohms
B and F	10 K ohms
C and F	6.2 K ohms
D and F	3.9 K ohms
E and F	1.6 K ohms

7. Replace ID module if testing determines that it is faulty.

NOTE: Do not attempt to remove cover of location ID module. There are no replaceable parts under cover.

8. After testing is completed, secure main wire harness connector to location ID module connector.

9. Plug the 48 VDC battery disconnect back into the socket.

10. Lower and secure operator seat and hood.

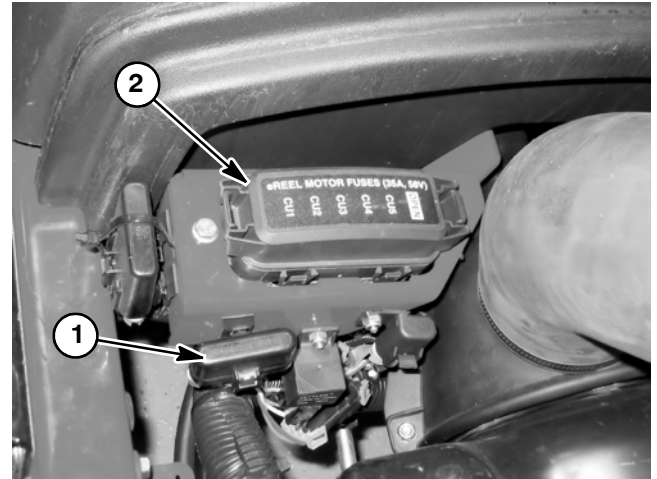


Figure 66

1. Location ID module
2. 48 VDC fuse block

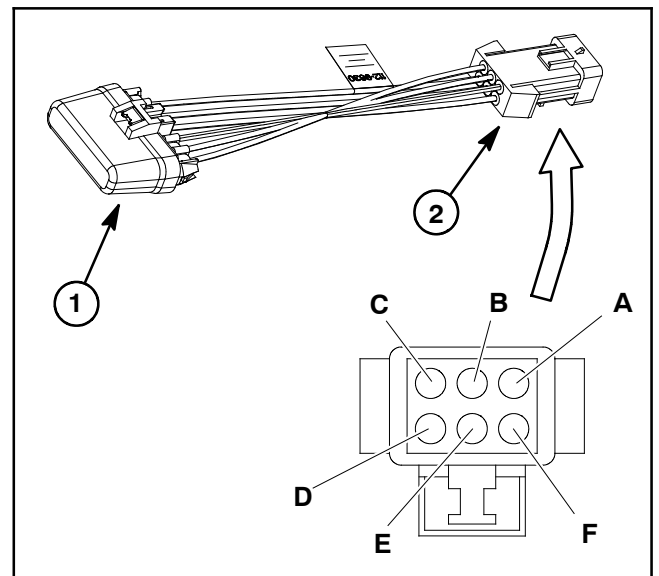


Figure 67

1. Location ID module
2. ID module connector

Cutting Reel Motor

The five (5) cutting reel motors are identical 48 VDC, brushless, permanent magnet motors. Each motor has its own integral inverter and on-board controller. The InfoCenter Display can be used to monitor the speed and current draw for the five (5) cutting unit motors during machine operation. Also, if a problem exists with any cutting reel motor, a fault may have occurred that would be indicated by a fault code on the InfoCenter Display.

Because the cutting reel motors used on the Reelmaster 5010- H are the same motors, motors from different cutting units can be exchanged. If the problem follows a motor to the new cutting unit, the motor is likely the issue. If the problem remains with the cutting unit, the issue is likely due to the cutting unit or electrical components or wiring to that cutting unit.

NOTE: Before considering that cutting reel motor service work is necessary, check for any existing fault codes that indicate problems with a reel motor (see Fault Codes in the Troubleshooting section of this chapter). If a cutting reel motor is faulty, there will likely be numerous fault codes that are listed by the InfoCenter display.

Testing

1. Park machine on level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.

2. Separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected cutting unit operation.

3. Locate cutting reel motor cable electrical connections at machine wire harness for motor that is to be tested.

IMPORTANT: When disconnecting reel motor cable connectors, take care to not damage the cable or connectors. The reel motor cable is not available as a separate replacement part.

4. Carefully disconnect two (2) reel motor cable connectors from machine wire harness (Fig. 68).

5. Using a multimeter, measure resistance between 48 VDC ground terminal (black wire) in the 2 wire connector and location ID terminal (blue wire) in 4 wire connector (Fig. 69). Resistance should be approximately **18.8 K-ohms**.

6. If measured resistance is incorrect, consider that the cutting reel motor is faulty.

NOTE: If cutting reel motor removal, installation, disassembly or assembly information is needed, see Cutting Reel Motor and Cutting Reel Motor Service in the Service and Repairs section of this chapter.

7. After testing is completed, secure two (2) reel motor cable connectors to machine wire harness connectors.

8. Plug the 48 VDC battery disconnect back into the socket.

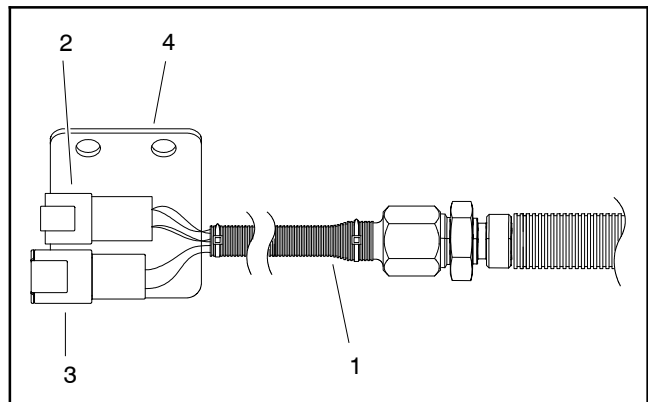


Figure 68

- | | |
|---------------------|---------------------|
| 1. Cable from motor | 3. 2 wire connector |
| 2. 4 wire connector | 4. Connector plate |

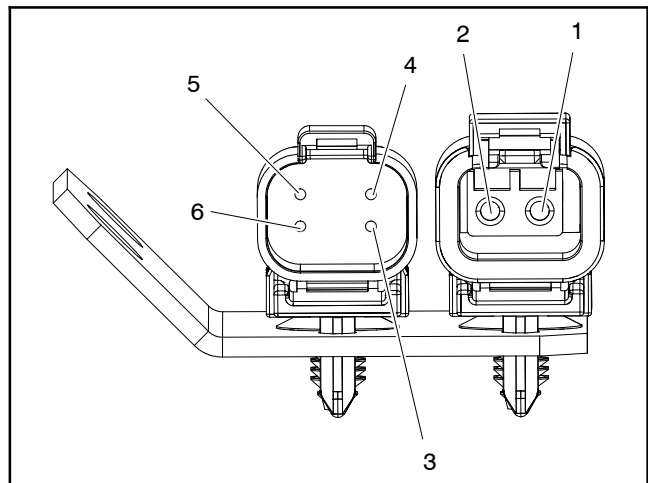


Figure 69

- | | |
|--------------------------|-------------------------|
| 1. 48 VDC ground (black) | 4. 48 VDC logic (white) |
| 2. 48 VDC power (red) | 5. CAN-bus (green) |
| 3. Location ID (blue) | 6. CAN-bus (yellow) |

CAN-bus Termination Resistors

System communication between electrical components on Reelmaster 5010-H machines is accomplished on two (2) CAN-bus communication systems: one for the 12 VDC system and one for the 48 VDC system. Two (2) specially designed, twisted cables form the bus for both of the networks used on the 5010-H machines. These wires provide the data pathways between machine electrical components. At the ends of the twisted pair of bus cables are 120 ohm termination resistors.

The twisted pair of bus wires for the 12 VDC circuits are black/white and red/white. The twisted pair of bus wires for the 48 VDC circuits are green and yellow.

The two (2) termination resistors for the 12 VDC electrical circuits have the following locations:

- A. In the control arm next to the operator seat.
- B. Near the wire harness connectors for the #3 (right rear) cutting unit motor on the right side of the machine.

The two (2) termination resistors for the 48 VDC electrical circuits have the following locations:

- A. Near the wire harness connectors for the #1 (front center) cutting unit motor under the footrest at the front of the machine.
- B. Near the 48 VDC reel motor fuse holder behind the hood saddle under the hood.

NOTE: Refer to the Electrical Schematics and Wire Harness Drawings in Chapter 9 - Foldout Drawings for additional information on termination resistor locations and wire connections.

IMPORTANT: The termination resistors at the ends of the bus cables are required for proper electrical system operation.

Termination Resistor Test

The termination resistors (Fig. 70) can be individually tested using a digital multimeter (ohms setting). Locate resistor and remove cable tie that secures resistor to wire harness. Unplug the resistor from the wire harness for testing.

NOTE: The insulator wedge in the termination resistor is blue for identification purposes. There also is a center keyway to prevent the termination resistor from plugging into the wrong wire harness connector.

Use a digital multimeter (ohms setting) to measure the resistance value for the termination resistor. There should be **120 ohms** resistance between terminals A and B. Refer to Fig. 70 to determine terminal locations. Terminal C is not used on Reelmaster 5010-H machines.

If testing determines that termination resistor is faulty, replace resistor.

After testing is complete, make sure that termination resistor is fully installed into wire harness connector and secured to wire harness with cable tie.

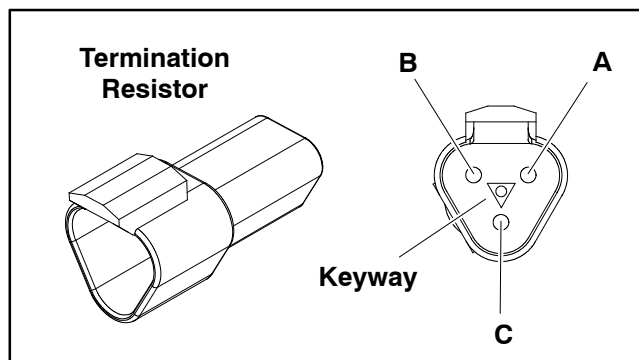


Figure 70

Hydraulic Solenoid Valve Coil

The Reelmaster hydraulic lift control manifold includes four (4) solenoid valves for system control (Fig. 71). When the solenoid coils are energized, hydraulic valve shift occurs to control hydraulic flow. Testing of the coils can be done with the coil installed on the hydraulic valve.

NOTE: If electrical problems exist with a solenoid valve coil, a fault may have occurred that would be indicated by a fault code on the InfoCenter Display. Before considering that solenoid valve coil service work is necessary, check for any existing fault codes that indicate problems with a coil.

Testing

NOTE: A solenoid valve coils **should** be tested as a TEC controller output with the InfoCenter Display before disconnecting and testing the coil (see Diagnostics Screen (PTO item) in the InfoCenter Display section of this chapter). The InfoCenter Display will identify if the TEC output to the solenoid coil exists when machine controls are in the correct position. If the TEC controller output exists for a solenoid coil but the coil is not functioning correctly, suspect a failed coil or an open in the solenoid valve coil circuit.

1. Park machine on level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.

2. Access to the lift control manifold can be obtained by removing the operator floor plate.

3. Disconnect wire harness electrical connector from hydraulic solenoid valve coil that is to be tested (Fig. 71).

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter may display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

4. Using a multimeter (ohms setting), measure resistance between the two connector terminals on the solenoid valve coil. The resistance for the solenoid coils is identified below:

Solenoid Valve Coil	Resistance
SV1 and SV3	8.7 ohms
SV2 and SVRV	7.1 ohms

5. If solenoid coil resistance is incorrect, replace solenoid coil (see Hydraulic Solenoid Valve Coil in the Service and Repairs section of this chapter).

NOTE: Solenoid valve coils SV2 and SVRV on the lift control manifold are identical. The remaining two lift manifold coils (SV1 and SV3) are identical. To assist in troubleshooting, identical coils can be exchanged. If the problem follows the exchanged coil, an electrical problem likely exists. If the problem remains unchanged, something other than the solenoid coil is the problem source (e.g. switch, circuit wiring, hydraulic problem).

6. After testing the coils, connect wire harness electrical connector to the solenoid valve coil.

7. Install operator floor plate.

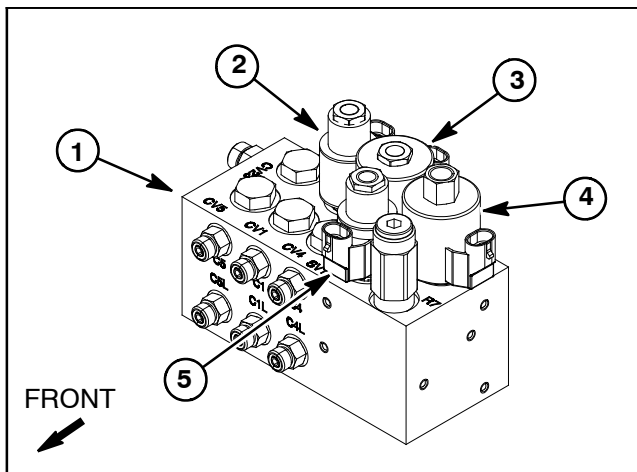


Figure 71

- | | |
|------------------|------------------|
| 1. Lift manifold | 4. SVRV solenoid |
| 2. SV3 solenoid | 5. SV1 solenoid |
| 3. SV2 solenoid | |

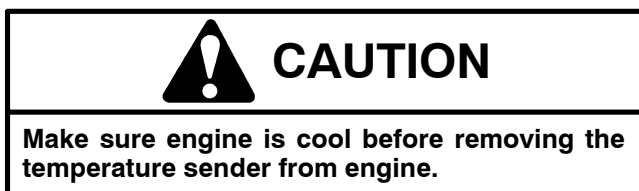
Temperature Sender

The temperature sender is located near the alternator on the water flange attached to the engine cylinder head (Fig. 72). The Toro Electronic Controller (TEC) monitors the operation of the temperature sender.

The resistance of the temperature sender reduces as the engine coolant temperature increases. The changing resistance of the temperature sender is used as an analog input to the TEC controller to indicate engine coolant temperature during machine operation.

Temperature Sender Test

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch. Open hood to gain access to engine.
2. Locate temperature sender on engine and disconnect wire harness connector from sender.



3. Lower coolant level in the engine and remove the temperature sender from water flange.
4. Put sender in a container of oil with a thermometer and slowly heat the oil (Fig. 73).



NOTE: Prior to taking resistance readings with a digital multi meter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less) due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

5. Check resistance of the sender with a multimeter (ohms setting) as the oil temperature increases.

A. The meter should indicate from 11.4 to 13.6 ohms at 68°F (20°C).

B. The meter should indicate from 2.3 to 2.6 ohms at 140°F (60°C).

C. The meter should indicate from 0.6 to 0.7 ohms at 212 °F (100°C).

6. Replace temperature sender if specifications are not met.

7. Install temperature sender to the water flange.

A. Clean threads of water flange and temperature sender thoroughly. Apply thread sealant to the threads of the sender.

B. Screw sender into the water flange until it is finger tight. Then, tighten sender an additional 2 to 3 full turns.

C. Connect wire harness connector to sender.

8. Fill engine cooling system. Close and secure hood.

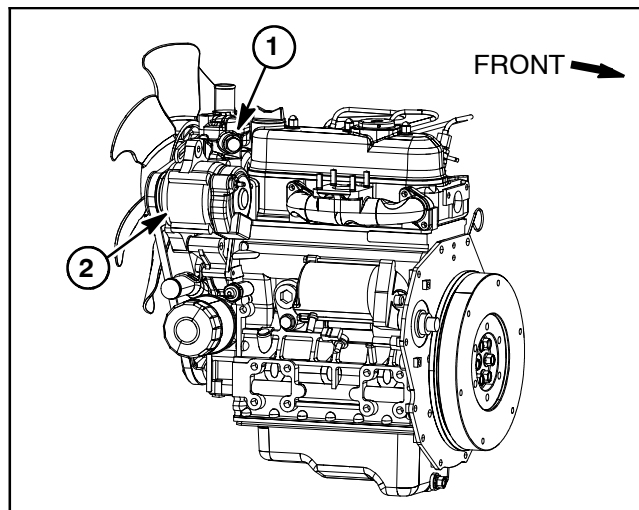


Figure 72

1. Temperature sender
2. Alternator

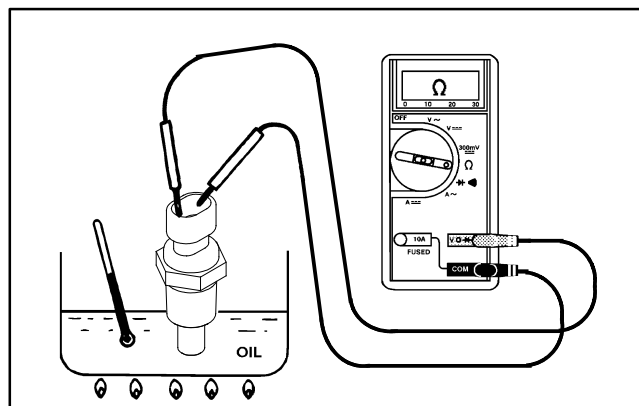


Figure 73

Oil Pressure Switch

The engine oil pressure switch is a normally closed switch that opens with pressure during normal engine operation. The oil pressure switch is located on the engine near the oil filter (Fig. 74). The Toro Electronic Controller (TEC) monitors the operation of the oil pressure switch.

The oil pressure switch should open at approximately 8 PSI (0.56 kg/cm²).

If low engine oil pressure allows the oil pressure switch to close during engine operation and the TEC controller detects a low oil pressure input for ten (10) seconds, the engine will be shut off by the controller. The operator will see an advisory (advisory #169) on the InfoCenter display explaining that low engine oil pressure has caused the engine shutdown.

NOTE: A faulty oil pressure switch or faulty wiring to the oil pressure switch could cause a closed circuit that would lead to engine shutdown with an InfoCenter display identifying Advisory #169.

Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.

2. Raise and support hood. Locate oil pressure switch on engine and disconnect the wire harness connector from the switch.

3. Use a digital multimeter to measure continuity between the oil pressure switch terminal and the switch base (ground connection) (Fig. 75).

A. With the engine not running, the oil pressure switch should be closed so there **should be** continuity between the switch terminal and the switch base (0 ohms).

B. With the engine running, the oil pressure switch should be open so there **should not be** continuity between the switch terminal and the switch base (infinite ohms).

4. Replace the oil pressure switch if testing determines that the switch is defective.

5. If testing of oil pressure switch determines that switch operation is normal and the InfoCenter display is identifying low engine oil as the cause of engine shut-down, check for faulty wire in the oil pressure switch circuit.

6. After testing is completed, connect the wire harness connector to the oil pressure switch. Lower and secure hood.

NOTE: Refer to Kubota Workshop Manual, Diesel Engine, 05- E4B Series for information regarding engine lubrication system and testing.

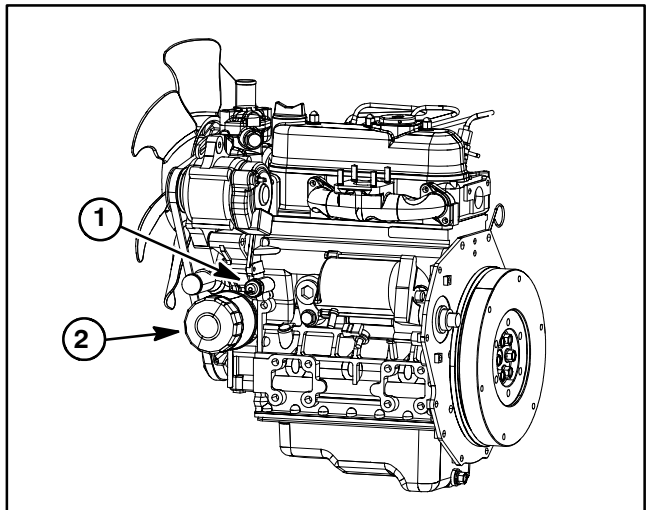


Figure 74

1. Oil pressure switch 2. Oil filter

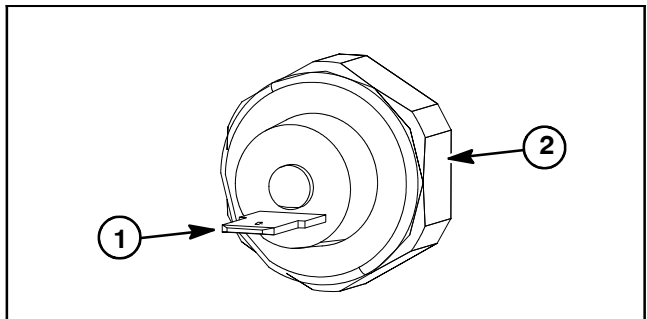


Figure 75

1. Switch terminal 2. Switch base

Fuel Actuator

The fuel actuator used on your Reelmaster must be energized by the TEC controller for the diesel engine to run. The actuator is mounted to the injection pump on the engine (Fig. 76).

The fuel actuator and TEC controller work together to maintain engine speed by adjusting the fuel delivery to the engine. A sensor in the motor/generator provides the generator/engine speed to the TEC controller via the CAN-bus. If there is a change in engine speed (e.g. load conditions change, engine speed switch pressed by operator), the TEC controller modifies the electrical output to the actuator which adjusts fuel as required to maintain engine speed.

The TEC controller monitors the operation of the fuel actuator. If the TEC controller detected a fuel actuator problem during engine operation, the InfoCenter Display can be used to identify the fault (see Fault Codes in the Troubleshooting section in this chapter).

NOTE: If a problem with the fuel actuator or circuit wiring exists, the extension spring attached to the actuator bracket and engine speed control lever will cause the engine to run at high idle (3150 RPM) with the engine mechanical governor maintaining engine speed. In this situation, the control arm mounted engine speed switch will not change engine speed and a fault code should be displayed on the InfoCenter Display.

Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch. Open hood to gain access to engine.

2. Locate fuel actuator and disconnect wire harness connector from fuel actuator.

NOTE: The fuel actuator may be tested in place or removed from the engine for testing.

3. If the actuator is removed from the engine, make sure that the actuator plunger moves freely and is free of dirt, debris and corrosion.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

4. Using a multimeter (ohms setting), measure resistance between the two terminals in the fuel actuator connector. Resistance should be from **5.0 to 5.5 ohms**.

5. If actuator coil resistance is incorrect, replace fuel actuator.

6. When testing is complete, connect wire harness connector to the fuel actuator.

7. Lower and secure hood.

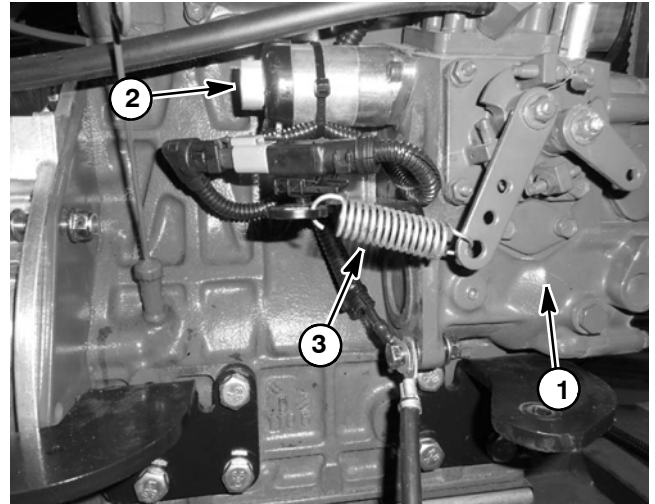


Figure 76

- 1. Injection pump
- 2. Fuel actuator
- 3. Extension spring

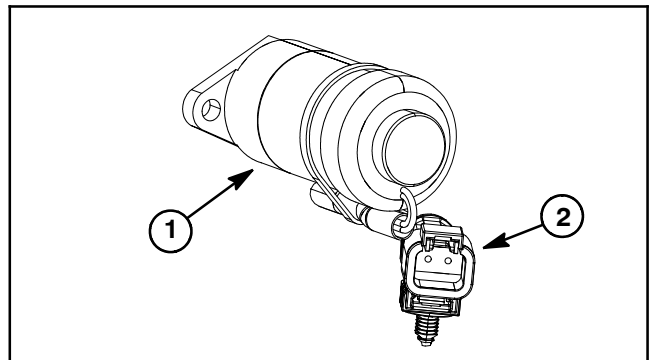


Figure 77


- 1. Fuel actuator
- 2. Actuator connector

Fuel Sender

The fuel sender is a variable resistance device that allows the InfoCenter display to show level of the fuel tank. The fuel sender is located in the fuel tank (Fig. 78).

Testing

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Remove screws that secure sender cover to fuel tank. Lift cover from tank.
3. Disconnect the wire harness connector from the fuel sender.

**CAUTION**

When testing circuit wiring and fuel sender, make sure wire connections are secure before turning ignition switch to ON to prevent an explosion or fire from sparks.

4. To test the circuit wiring and InfoCenter fuel gauge, use a jumper wire to connect the two (2) terminals in the wire harness connector. Make sure that jumper wire connections are secure. Turn the ignition switch to the ON/PREHEAT position. InfoCenter display should indicate a full fuel tank if circuit wiring and InfoCenter are working correctly. Turn ignition switch OFF and continue testing fuel sender if circuit wiring and InfoCenter are acceptable.

5. Loosen hose clamps and carefully disconnect supply and return fuel hoses from fittings on the top of the fuel sender.

IMPORTANT: Before removing fuel sender from tank, note orientation of fuel sender fittings for assembly purposes (Fig. 79).

6. Carefully remove fuel sender cap that secures the fuel sender in the fuel tank.

7. Raise fuel sender and gasket from the fuel tank. Clean all fuel from the sender.

**CAUTION**

Make sure fuel sender is completely dry (no fuel on it) before testing. Perform test away from the tank to prevent an explosion or fire from sparks.

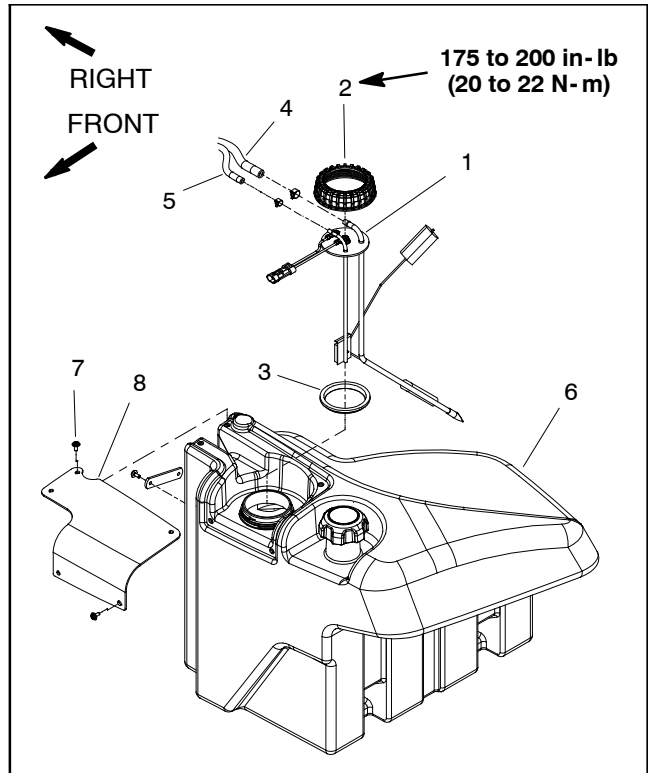


Figure 78

- | | |
|----------------------|---------------------|
| 1. Fuel gauge sender | 5. Fuel return hose |
| 2. Fuel sender cap | 6. Fuel tank |
| 3. Gasket | 7. Screw (5 used) |
| 4. Fuel supply hose | 8. Sender cover |

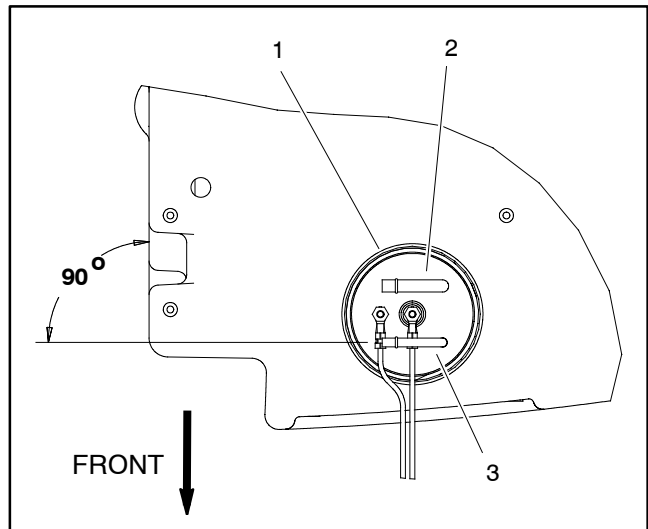


Figure 79

- | | |
|------------------------|------------------------|
| 1. Fuel sender | 3. Fuel return fitting |
| 2. Fuel supply fitting | |

8. Use a multimeter to check resistance of the fuel sender across the two (2) sender terminals (Fig. 80).

A. Resistance with the float in the full position (completely up) should be from 5 to 8 ohms.

B. Resistance with the float in the empty position (completely down) should be from 89 to 95 ohms.

9. Replace fuel sender if testing determines that it is faulty.

10. After testing, install sender into fuel tank and secure with gasket and fuel sender cap. Make sure that fuel fittings on sender are orientated at 90° from right side of tank as shown in Figure 79. Also, to prevent damage to fuel sender during assembly, make sure that fuel sender does not turn as sender cap is tightened.

11. Install fuel hoses to fittings on sender and secure with hose clamps. Connect fuel sender connector to wire harness.

12. Secure sender cover to fuel tank with removed screws.

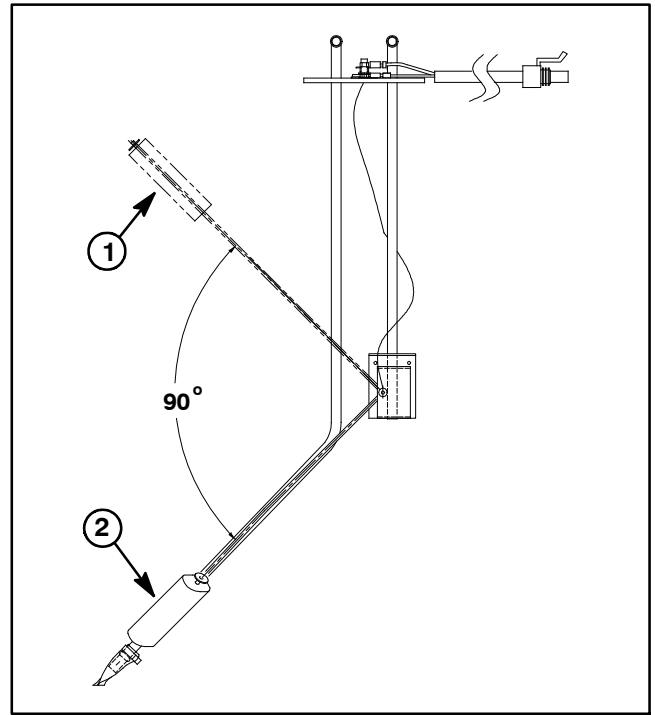


Figure 80

1. Sender full position

2. Sender empty position

Fuel Pump

The Reelmaster electric fuel pump is attached to the inside of the left side frame rail near the fuel tank (Fig. 81).

IMPORTANT: When testing fuel pump, make sure that pump is not operated without fuel.



DANGER

Because diesel fuel is flammable, use caution when handling it. Do not smoke while testing the fuel pump. Do not test fuel pump while engine is hot. Make sure that there is adequate ventilation when testing. Always wipe up any spilled fuel before starting the engine.

Fuel Pump Capacity Test

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch. Raise operator seat and hood.
2. Disconnect wire harness electrical connector from the engine fuel actuator to prevent the engine from starting (see Fuel Actuator in this section).
3. Disconnect fuel hose (pump discharge) from the fuel/water separator inlet fitting (Fig. 82).
4. Make sure fuel hoses attached to the fuel pump, fuel filter and fuel tank suction tube screen are free of obstructions.
5. Place disconnected hose into a large, graduated cylinder large enough to collect 1 quart (0.95 liter).

IMPORTANT: When testing the fuel pump, DO NOT turn ignition switch to START.

6. Collect fuel in the graduated cylinder by turning ignition switch to the ON/PREHEAT position. Allow pump to run for fifteen (15) seconds, then return ignition switch to OFF.
7. The amount of fuel collected in the graduated cylinder should be approximately **16 fl oz (475 ml) after fifteen (15) seconds.**
8. Replace fuel pump if testing proves it to be faulty.
9. When testing is complete, install fuel hose to the fuel/water separator. Make sure to secure fuel hose with hose clamp.

10. Connect wire harness electrical connector to the engine fuel actuator.

11. Bleed the fuel system.

12. Lower and secure operator seat and hood.

Fuel Pump Specifications

Pump Capacity	64 fl oz/min (1.9 liters/min)
Pressure	7 PSI (48.3 kPa)
Current Draw	2.0 amp

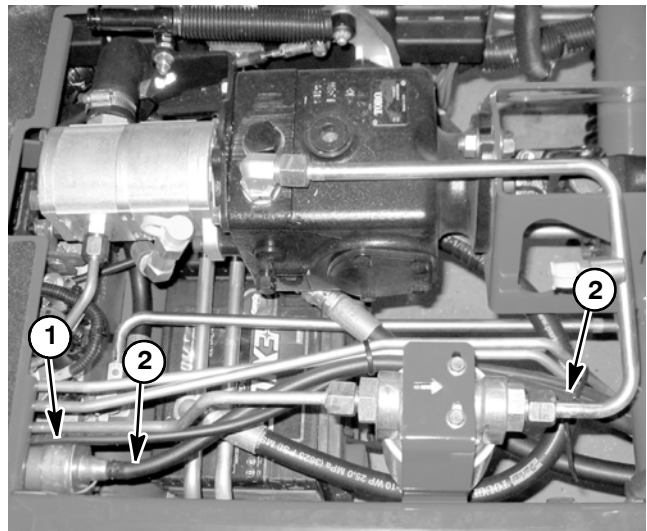


Figure 81

1. Fuel pump

2. Pump discharge hose

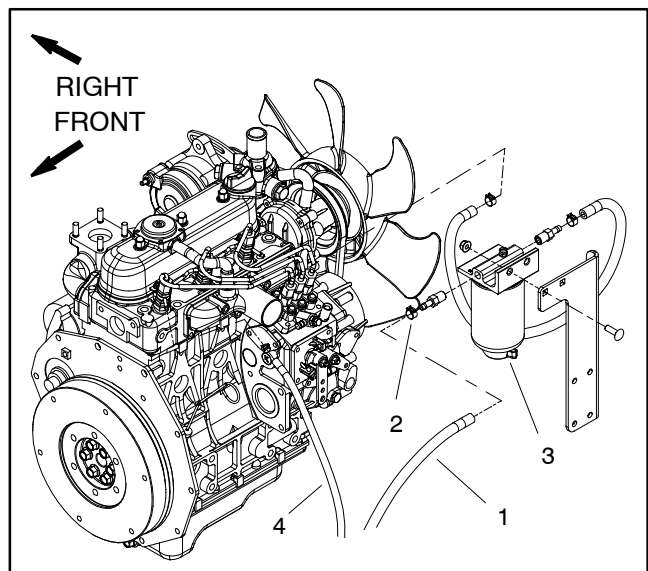


Figure 82

1. Fuel hose (from pump)

2. Hose clamp

3. Fuel/water separator

4. Fuel return hose

Service and Repairs

NOTE: See the Kubota Workshop Manual, Diesel Engine, 05- E4B Series for engine electrical component repair information.

Hydraulic Solenoid Valve Coils

A hydraulic solenoid valve coil on the lift control manifold (Fig. 83) can be replaced without opening the hydraulic system.

Removal

1. Park machine on a level surface, lower cutting units, stop engine and engage parking brake. Remove key from ignition switch.
2. The lift control manifold is attached to a frame bracket under the operator floor plate. Access to the lift control manifold can be obtained by removing the floor plate. Refer to Figure 83 for solenoid coil locations on the lift control manifold.
3. Disconnect the wire harness electrical connector from the solenoid valve coil to be replaced.
4. Remove the nut from the hydraulic valve.
5. If equipped (SV1 and SV3 on lift control manifold), remove coil spacer from hydraulic valve.
6. Slide the solenoid coil from the valve.
7. Clean any corrosion or dirt from the valve.

Installation

1. Slide new coil assembly onto the hydraulic valve.
2. If equipped (SV1 and SV3 on lift control manifold), slide coil spacer onto hydraulic valve.
3. Install the nut onto the valve and torque nut **60 in-lb (6.7 N-m)** (do not over tighten).
4. Connect the machine wire harness connector to the solenoid coil.

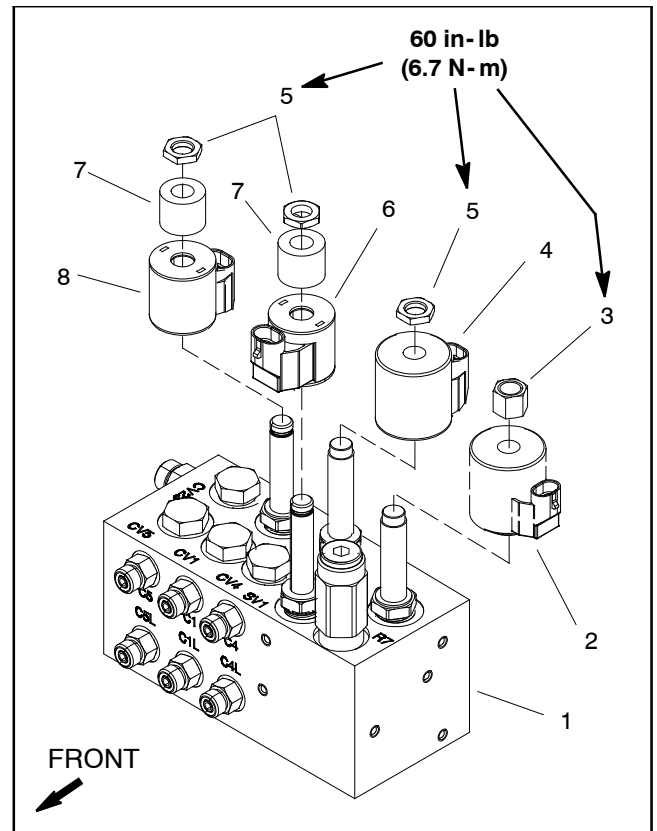


Figure 83

- | | |
|--------------------------|----------------------|
| 1. Lift control manifold | 5. Nut |
| 2. Solenoid coil SVRV | 6. Solenoid coil SV1 |
| 3. Nut | 7. Coil spacer |
| 4. Solenoid coil SV2 | 8. Solenoid coil SV3 |

12 VDC Battery Service

The battery is the heart of the 12 VDC electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.



CAUTION

When working with batteries, use extreme caution to avoid splashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Battery Specifications

BCI Group Size 55
585 CCA at 0° F (- 18°C)
95 minutes reserve capacity at 80°F (27°C)

Electrolyte Specific Gravity

Fully charged: 1.265 corrected to 80°F (27°C)
Discharged: less than 1.240

Removal and Installation (Fig. 84)

1. Park machine on level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.
2. Open screen at rear of machine and remove battery cover to access battery.
3. Loosen and remove negative cable from battery. After negative cable is removed, loosen and remove positive cable.
4. Loosen flange nut that secures battery retainer.
5. Carefully remove battery from machine.
6. Install battery in reverse order making sure to connect and tighten positive cable to battery before connecting negative cable.

NOTE: Before connecting the negative (ground) cable to the battery, connect a digital multimeter (set to DC Amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 Amp. If the reading is 0.1 Amp or more, the machine's electrical system should be tested for short circuits or faulty components and repaired.

7. Coat battery posts and cable connectors with Battery Terminal Protector (Toro Part No. 107-0392) or petroleum jelly to prevent corrosion.

8. Install battery cover. Close and secure screen.

Battery Inspection and Maintenance

1. Check battery for cracks. Replace battery if cracked or leaking.
2. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

IMPORTANT: Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

3. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

4. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

5. If the battery electrolyte is accessible, check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled** water between the minimum and maximum fill lines. Do not fill cells above the fill line. Charge at 15 to 25 Amps for fifteen (15) minutes to allow sufficient mixing of the electrolyte.

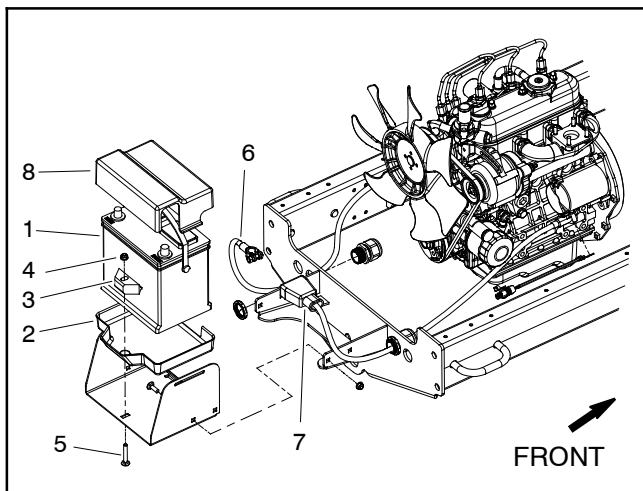


Figure 84

- | | |
|-------------------|---------------------------|
| 1. 12 VDC battery | 5. Carriage screw |
| 2. Battery tray | 6. Negative battery cable |
| 3. Retainer | 7. Positive battery cable |
| 4. Flange nut | 8. Battery cover |

Battery Storage

If the machine will be stored for more than thirty (30) days:

1. Charge battery fully before storing the machine (see Battery Service in this section).
2. Either remove battery from machine and store on a shelf or leave battery on the machine. If the battery is stored on the machine, leave battery cables disconnected.
3. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.
4. To help prevent the battery from freezing during storage, make sure it is fully charged (see Battery Service in this section).

Battery Testing

1. Perform a high-discharge test with an adjustable load tester. This is one of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is **required** to perform this test.

 <h2 style="margin: 0; display: inline;">CAUTION</h2>
<p>Follow the manufacturer's instructions when using a battery load tester.</p>

- A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, charge the battery before performing a load test.
- B. If the battery has recently been charged, use a battery load tester following the manufacturer's instructions to apply a 150 Amp load for fifteen (15) seconds. This step will remove the surface charge.
- C. Make sure battery terminals are free of corrosion.
- D. Estimate the internal temperature of the battery to the nearest 10 degrees F.
- E. Connect a battery load tester to the battery terminals following the manufacturer's instructions. Connect a digital multimeter to the battery terminals.
- F. Apply a test load of 270 Amps (one half the cranking performance rating of the battery) to the battery for fifteen (15) seconds.
- G. Take a battery voltage reading at fifteen (15) seconds, then remove the load.

H. Using the table in the column to the right, determine the minimum voltage for the battery temperature reading. If the test voltage is below the minimum voltage for the battery temperature, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Minimum Voltage	Battery Temperature	
9.6	70°F (and up)	21°C (and up)
9.5	60°F	16°C
9.4	50°F	10°C
9.3	40°F	4°C
9.1	30°F	-1°C
8.9	20°F	-7°C
8.7	10°F	-12°C
8.5	0°F	-18°C

2. If the battery electrolyte is accessible, the specific gravity of the electrolyte can be used to determine the battery condition.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm-up the hydrometer. At the same time take the temperature of the cell.

B. Temperature correct each cell reading. For each 10°F (5.5°C) above 80°F (26.7°C) add 0.004 to the specific gravity reading. For each 10°F (5.5°C) below 80°F (26.7°C) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature	100°F
Cell Gravity	1.245
100°F minus 80°F equals 20°F	
(37.7°C minus 26.7°C equals 11.0°C)	
20°F multiply by 0.004/10°F equals 0.008	
(11°C multiply by 0.004/5.5°C equals 0.008)	
ADD (conversion above)	<u>0.008</u>
Correction to 80°F (26.7°C)	1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Battery Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

Battery Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is readily available.



CAUTION

Follow the manufacturer's instructions when using a battery charger.

NOTE: Using specific gravity of the battery electrolyte is the most accurate method of determining battery condition.

1. Determine the battery charge level from either its open circuit voltage or electrolyte specific gravity (if electrolyte is accessible).

Battery Charge Level	Open Circuit Voltage	Specific Gravity
100%	12.6	1.265
75%	12.4	1.225
50%	12.2	1.190
25%	12.0	1.155
0%	11.8	1.120

2. Determine the charging time and rate using the battery charger manufacturer's instructions or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 Amps	7.5 hrs @ 3 Amps	11.3 hrs @ 3 Amps	15 hrs @ 3 Amps
81 to 125	5.3 hrs @ 4 Amps	10.5 hrs @ 4 Amps	15.8 hrs @ 4 Amps	21 hrs @ 4 Amps
126 to 170	5.5 hrs @ 5 Amps	11 hrs @ 5 Amps	16.5 hrs @ 5 Amps	22 hrs @ 5 Amps
171 to 250	5.8 hrs @ 6 Amps	11.5 hrs @ 6 Amps	17.3 hrs @ 6 Amps	23 hrs @ 6 Amps
above 250	6 hrs @ 10 Amps	12 hrs @ 10 Amps	18 hrs @ 10 Amps	24 hrs @ 10 Amps



CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60°F (16°C) before connecting to a charger.

Charge the battery in a well-ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

3. Following the battery charger manufacturer's instructions, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery following the battery charger manufacturer's instructions.

5. While charging, occasionally check the battery. If the electrolyte is violently gassing or spewing or if the battery case feels hot to the touch, the charging rate must be lowered or temporarily stopped.

6. Determine if battery is fully charged before removing battery from charger. Either of the following procedures can be used:

A. Continue charging and reduce charging rate as needed until a two (2) hour period results in no increase in voltage. Open circuit voltage should be approximately 12.6 volts for a fully charged battery.

B. If the battery electrolyte is accessible, three (3) hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three (3) consecutive readings.

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48 VDC Battery Pack Service (Cutting Reel and Motor/Generator Systems)

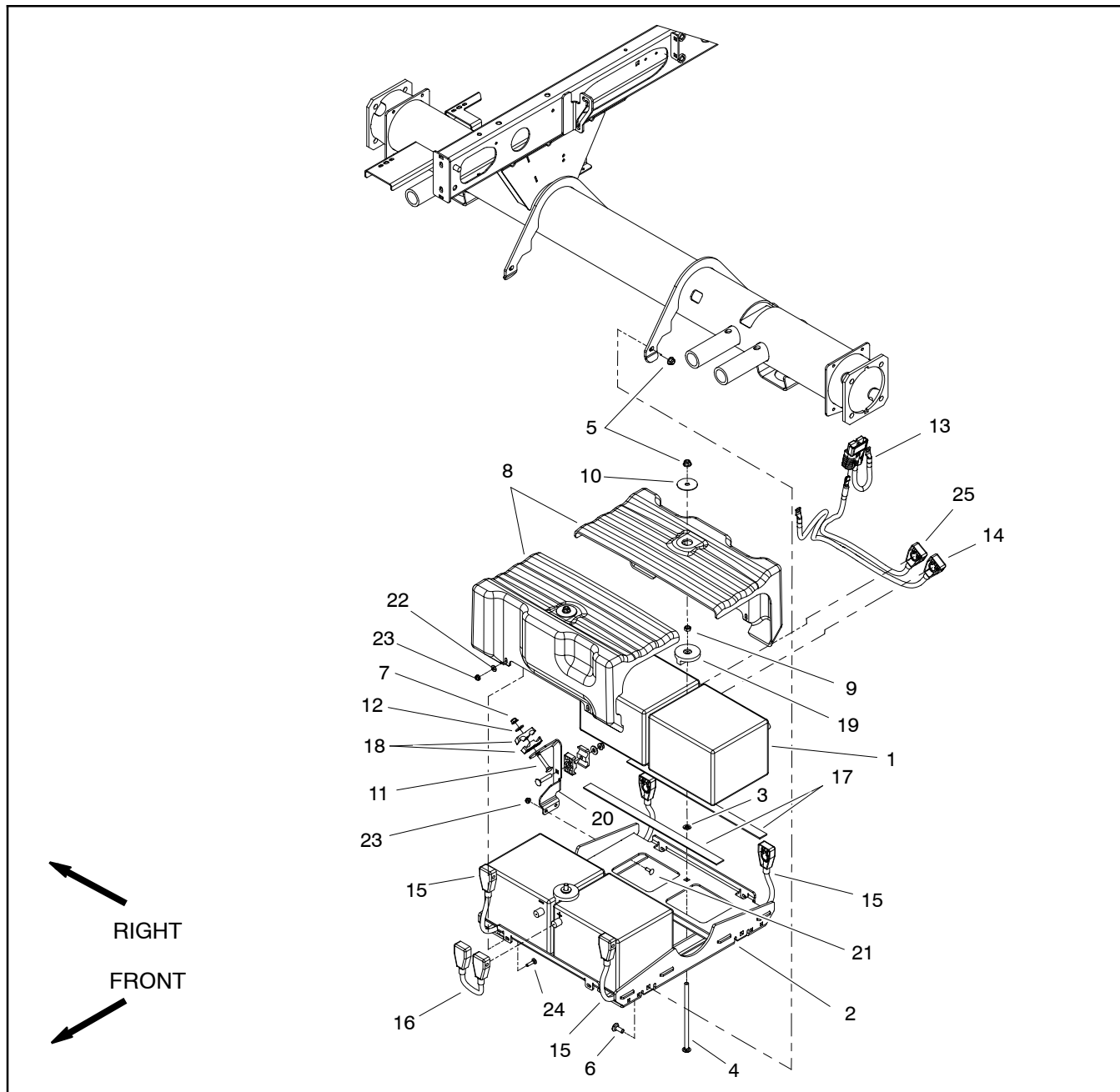


Figure 85

- | | | |
|----------------------------|----------------------------------|--------------------------------|
| 1. Battery (4 used) | 10. Flat washer (2 used) | 18. Clamp (4 used) |
| 2. Battery tray | 11. Carriage screw (2 used) | 19. Battery hold down (2 used) |
| 3. Push nut (2 used) | 12. Flat washer (2 used) | 20. Cable bracket |
| 4. Carriage screw (2 used) | 13. Battery disconnect connector | 21. Carriage bolt (2 used) |
| 5. Flange nut (6 used) | 14. Negative battery cable | 22. Flat washer (4 used) |
| 6. Carriage bolt (4 used) | 15. Battery cable (2 used) | 23. Flange nut (6 used) |
| 7. Flange nut (2 used) | 16. Battery jumper cable | 24. Carriage screw (4 used) |
| 8. Battery cover (2 used) | 17. Foam strip (4 used) | 25. Positive battery cable |
| 9. Hex nut (2 used) | | |

The 48 volt battery pack used in the Reelmaster 5010- H electric reel drive system is composed of four (4) 12 volt batteries that are connected in series. The batteries are absorbed glass mat (AGM), valve regulated batteries that are maintenance free with no provision for checking or adjusting electrolyte level. The batteries are equipped with a low pressure venting system designed to release excess gas pressure and then automatically reseal. A low self discharge rate prevents deterioration of battery performance during non- use or storage.

Before performing any service on the batteries in the 48 VDC system, disconnect the 48 VDC system components from the electrical power supply by separating the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected system operation.

Battery Specifications

Battery capacity 53 AH
650 CCA at 0° F (- 18°C)



WARNING

POTENTIAL HAZARD:

The battery terminals, metal tools and metal vehicle parts could short together.

WHAT CAN HAPPEN:

Sparks can cause battery gasses to explode.

Damaged cables could short against metal vehicle parts and cause sparks.

HOW TO AVOID THE HAZARD:

When removing or installing the batteries, do not allow the battery terminals to short against metal parts of the vehicle.

Do not allow metal tools or metal vehicle parts to short between the battery terminals or battery cables.

Always keep the battery retainers in place to protect and secure the batteries.

48 VDC Battery Pack Removal (Fig. 85)

1. Park machine on level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.
2. Separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect. (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected 48 VDC system component operation.
3. Remove battery covers to gain access to batteries.

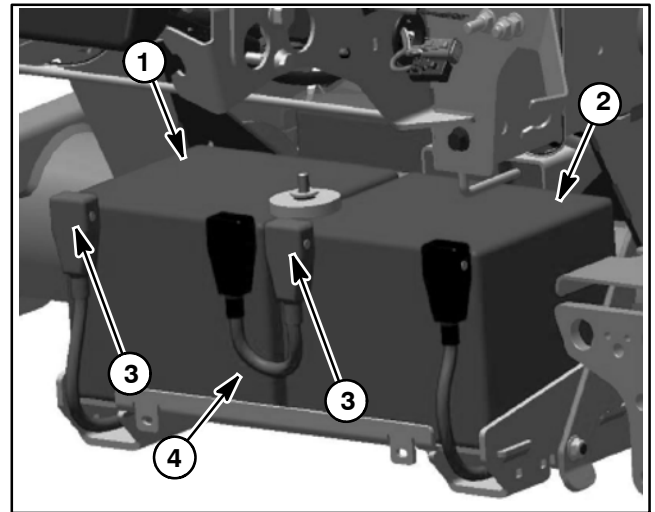


Figure 86

- | | |
|---------------------|----------------------|
| 1. RH front battery | 3. Positive terminal |
| 2. LH front battery | 4. Jumper cable |

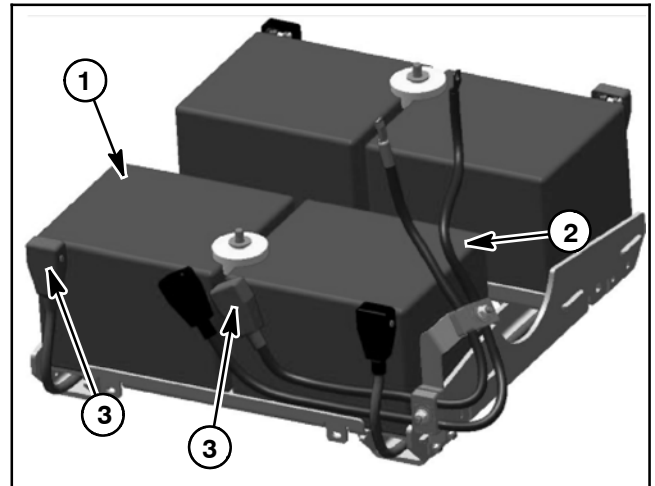


Figure 87

- | | |
|--------------------|----------------------|
| 1. LH rear battery | 3. Positive terminal |
| 2. RH rear battery | |

4. Carefully remove battery jumper cable (item 16) from front batteries to open battery circuit. Do not allow tools or vehicle components to complete the battery circuit during cable removal.
5. Remove remaining cables from battery terminals. Position battery cables away from battery terminals.
6. Remove hex nut and battery hold down that secure batteries to battery tray.
7. Carefully remove batteries from battery tray and machine.
8. If battery cable removal is needed, note routing of cables for installation purposes before removing cables from machine.
9. Inspect foam strips on battery tray. Replace strips if damaged.

48 VDC Battery Pack Installation (Fig. 85)

1. Make sure that the 48 VDC battery disconnect is separated to prevent unexpected 48 VDC system component operation (see 48 VDC Battery Disconnect in the General Information section of this chapter).
2. Make sure the battery tray is clean and repainted if necessary. Make sure battery cables, battery terminals and all hold down fasteners are in good condition.
3. If battery cables were removed, install cables in positions noted during disassembly. If cables were removed from rear batteries, make sure that cables are correctly routed through clamps and secured with removed fasteners.
4. Place batteries onto battery tray in machine.
5. Secure each battery with battery hold down and hex nut.

IMPORTANT: When connecting the battery pack in the 48 volt system, make sure that battery polarity is carefully checked. Damage to fuses or other system components can occur if batteries are not connected correctly.

6. Install all of the battery cables except the battery jumper cable (item 16). Make sure that cables are connected to correct battery terminal noting battery polarity as shown in Figures 86 and 87. Torque nuts on battery cable clamps from **50 to 70 in-lb (5.7 to 7.9 N-m)**.
7. Carefully install battery jumper cable (item 16) to front batteries. Do not allow tools or vehicle components to complete the battery circuit during cable installation. Torque nuts on battery jumper cable clamps from **50 to 70 in-lb (5.7 to 7.9 N-m)**.
8. Apply Toro battery terminal protector (see Special Tools in this chapter) to all battery posts and cable connectors to reduce corrosion after cable connections are made. Make sure that terminal boots are positioned over all cable connections.
9. Install battery covers.
10. Plug the 48 VDC battery disconnect back into the socket before operating the machine.

48 VDC Battery Pack Service

Clean the battery pack with clean water and a towel. Do not use solvents or chemicals to clean the battery pack.

When testing batteries in the battery pack of your Reelmaster, it is important to test all four (4) individual batteries. Proper performance of the machine depends on all batteries being in good condition. Testing will determine if one (or more) of the batteries needs to be replaced.

A simple battery test can be done using a multimeter to perform a voltage test of each of the batteries in the battery pack. Measure the battery voltage with the multimeter and record battery voltage. The measured voltage can be used to determine battery state of charge. If the voltage of any of the batteries varies by more than 10%, it indicates a problem with the battery that has the lower voltage.

If the battery pack system voltage drops below 50 VDC due to storage, age or malfunction, battery inspection and/or charging may be necessary. The batteries should be individually charged with a 12 VDC charger rated for operation with absorbed glass mat (AGM), valve regulated lead acid batteries. Charge the batteries following the battery charger manufacturer's instructions. Maximum charge voltage should be limited to 14.8 VDC. Operation of the machine will also charge the batteries in the 48 VDC system.

A battery load tester can be used to test individual batteries. Many locally available battery load testers do not, however, have any adjustment on the load that is put on the battery. Results received from using load testers should follow the recommendations of the load tester manufacturer.

48 VDC Battery Pack Storage

There are no special procedures or precautions for battery storage less than six (6) months. Batteries should be disconnected from all potential load sources during storage. Recommended storage temperatures should be between 50°F and 77°F (10°C to 25°C). Storage at elevated temperatures will result in accelerated rates of self discharge. Make sure that batteries are fully charged prior to storage. If battery pack is stored in a discharged state, battery performance and life will be diminished.

During storage, battery charging is recommended whenever voltage of an individual battery drops below 12.7 VDC.

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48 VDC Electrical Power Connections

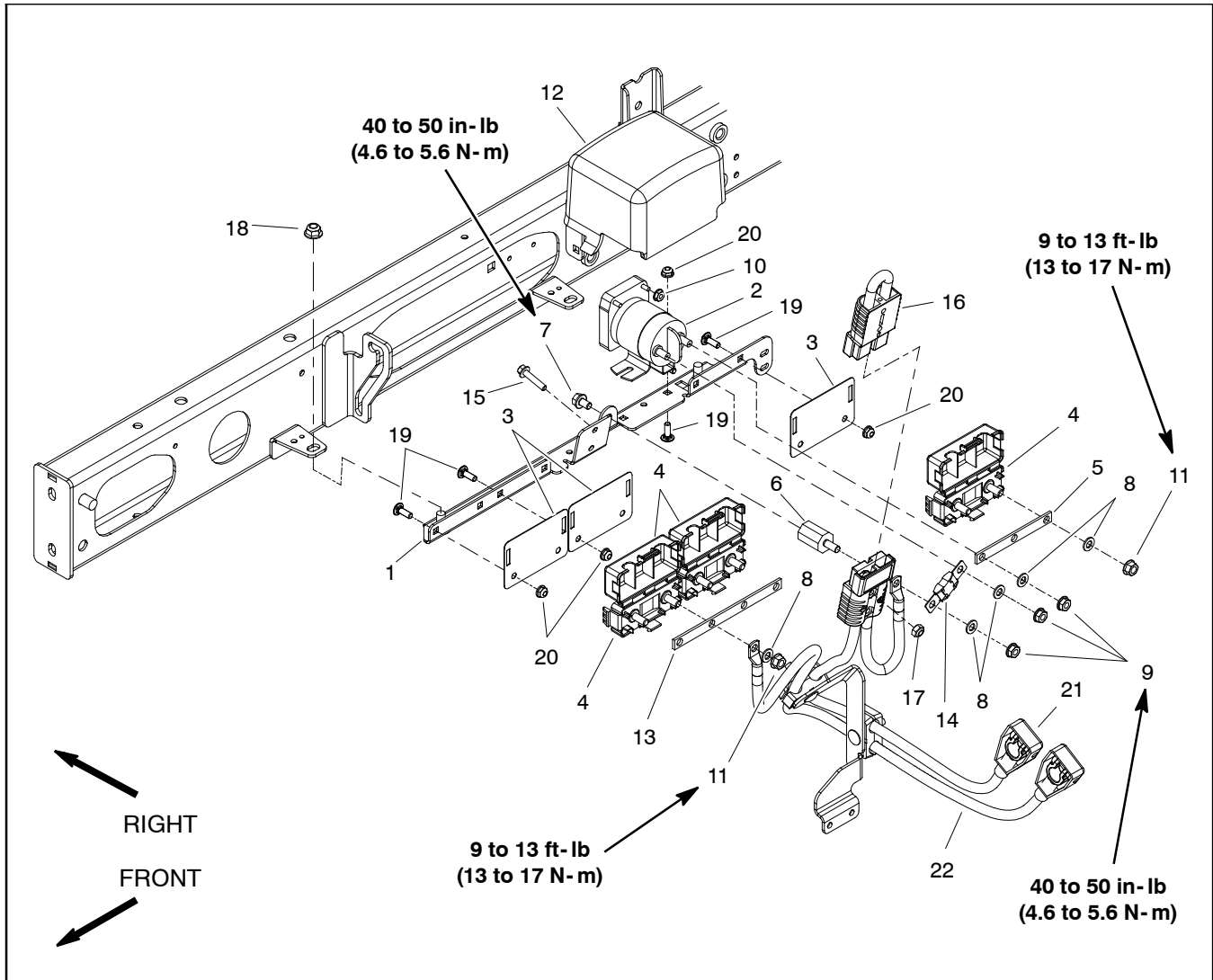


Figure 88

- | | | |
|--|---------------------------------------|-------------------------------|
| 1. Bracket | 9. Flange nut (3 used) | 16. 48 VDC battery disconnect |
| 2. Main contactor | 10. Nut (2 used) | 17. Lock nut (2 used) |
| 3. Holder bracket (3 used) | 11. Flange nut (6 used) | 18. Flange nut (2 used) |
| 4. Jumper strap holder (3 used) | 12. Contactor cover | 19. Carriage screw (8 used) |
| 5. Jumper strap (positive connections) | 13. Jumper strap (ground connections) | 20. Flange nut (8 used) |
| 6. Isolator | 14. 250 amp fuse | 21. Positive battery cable |
| 7. Flange head screw | 15. Flange head screw (2 used) | 22. Negative battery cable |
| 8. Flat washer (9 used) | | |

Disassembly

1. Park machine on level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.

2. Separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect. (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected 48 VDC system component operation.

3. Raise and support operator seat to access 48 VDC power connections. If front jumper strap holders for ground (negative) connections are to be accessed, remove operator floor plate from frame.

4. Label all wire connector locations for assembly purposes.

5. Disconnect electrical connections and remove components as needed using Figures 88, 89 and 90 as guides.

Assembly

1. Install all removed components and electrical connections as needed using Figures 88, 89 and 90 as guides. Use torque specifications identified in Figure 88 when installing fasteners.

2. Apply Toro battery terminal protector (see Special Tools in this chapter) to all cable connectors to reduce corrosion after cable connections are made. Make sure that terminal boots and connection covers are positioned over all cable connections.

3. If operator floor plate was removed, secure floor plate to frame with removed fasteners.

4. Plug the 48 VDC battery disconnect back into the socket when all electrical components have been installed to machine.

5. Lower and secure operator seat.

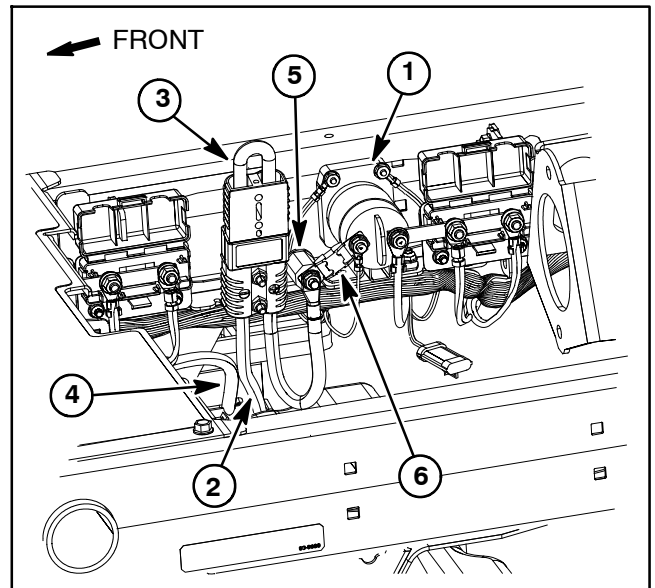


Figure 89

- | | |
|---------------------------|---------------------------|
| 1. Main contactor | 4. Negative battery cable |
| 2. Positive battery cable | 5. Isolator |
| 3. 48V battery disconnect | 6. Fuse (250A / 58V) |

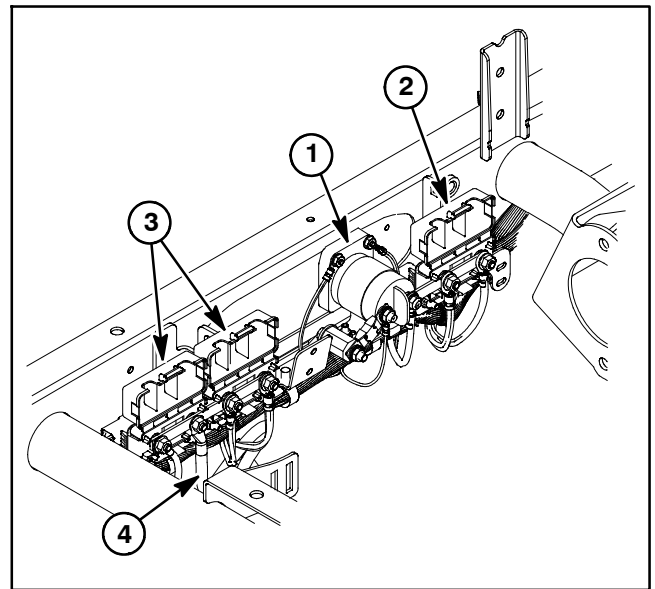


Figure 90

- | | |
|-------------------------|-----------------------|
| 1. Main contactor | 3. Ground connections |
| 2. Positive connections | 4. Neg battery cable |

Cutting Reel Motor

NOTE: If electrical problems exist with a cutting reel motor, a fault may have occurred that would be indicated by a fault code on the InfoCenter Display. Before considering that reel motor service work is necessary, check for any existing fault codes that indicate problems with a reel motor (see Fault Codes in the Troubleshooting section of this chapter).

IMPORTANT: When performing service or maintenance on the cutting reel motors, take care to not damage the motors or electrical connections.

Removal

1. Park machine on level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.

2. Separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect. (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected 48 VDC system component operation.

IMPORTANT: When removing cutting reel motor, take care to not damage the cable. The cable is not available as a replacement part.

3. Remove cutting reel motor from cutting unit (Fig. 91):

A. Loosen two (2) cap screws that secure the cutting reel motor to the cutting unit side plate.

B. Rotate motor clockwise to disengage motor flange from cap screws and remove motor from cutting unit. Position and support reel motor away from cutting unit.

4. Remove O-ring from flange of motor and discard O-ring.

5. Inspect cutting reel threaded insert splines for wear. Replace inserts if necessary (see Cutting Reel Assembly in the Service and Repairs section of Chapter 7 Cutting Units).

6. The cutting unit side plates have threaded inserts at the locations used for the cap screws that secure the reel motor. Check the condition of the threaded inserts and replace inserts if damage is found. Inserts should be torqued from **35 to 40 ft-lb (48 to 54 N-m)** during installation.

7. Place protective plastic cap (see Special Tools in this chapter) into the hole in the cutting unit side plate to prevent debris entry into reel bearing area.

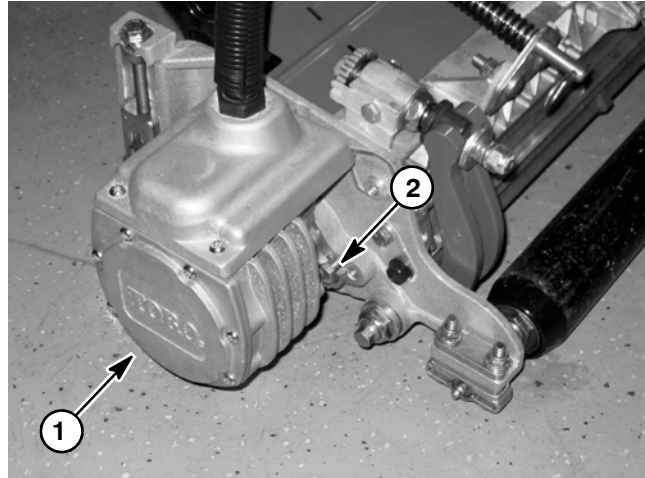


Figure 91

1. Cutting reel motor 2. Cap screw

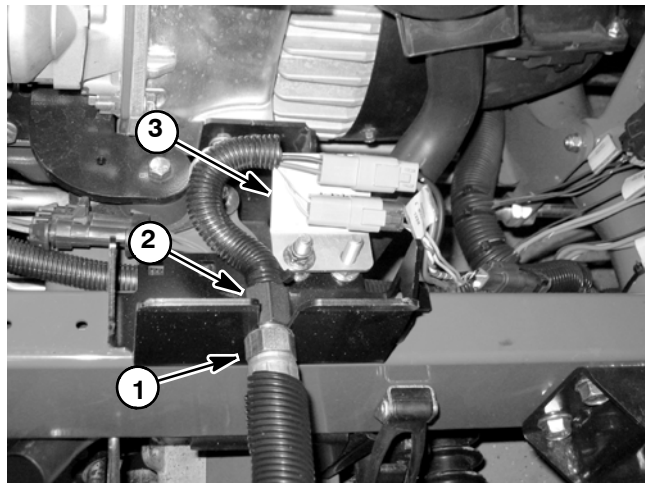


Figure 92

1. Bulkhead nut 3. Connector plate
2. Bulkhead fitting

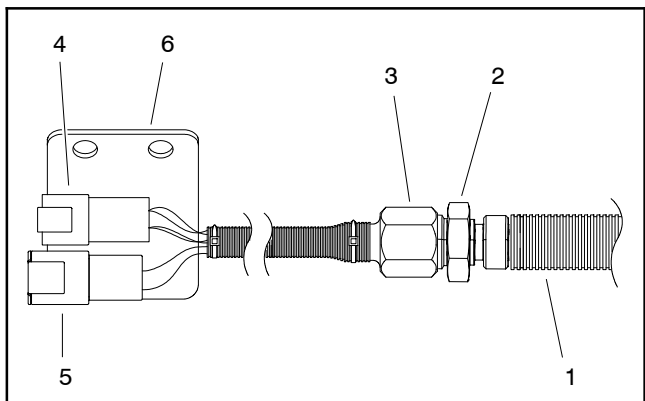


Figure 93

1. Cable from motor 4. 4 wire connector
2. Bulkhead nut 5. 2 wire connector
3. Bulkhead fitting 6. Connector plate

8. If cutting reel motor is to be removed from machine, disconnect reel motor cable from machine wire harness (Figs. 92 and 93):

- A. Locate reel motor cable electrical connections at machine wire harness for motor that is to be removed.
- B. Disconnect two (2) motor cable connectors from machine wire harness.
- C. Remove flange nut that secures reel motor cable connector plate to machine frame and separate motor cable from machine.
- D. Locate and loosen bulkhead nut that secures reel motor cable to bulkhead bracket on machine. Separate cable from bracket.

9. Remove cutting reel motor with attached cable from machine.

Installation

NOTE: Refer to Figure 94 for correct placement of cutting unit reel motors and weights.

- 1. Install new O-ring to flange of cutting unit motor. Coat spline shaft of the reel motor with No. 2 multipurpose lithium base grease.
- 2. Remove protective plastic cap from the hole in the cutting unit side plate.
- 3. Make sure that the two (2) cap screws for the cutting reel motor are installed into the cutting unit side plate with approximately 1/2 inch (12.7 mm) of threads exposed on each screw.
- 4. Secure cutting reel motor to cutting unit (Fig. 91):
 - A. Rotate the motor clockwise so the motor flanges clear the cap screws in the cutting unit side plates. Align reel motor shaft splines with cutting reel insert splines. Slide motor shaft into cutting reel threaded insert. Make sure that cable is on the upper side of the motor after installation.
 - B. Rotate the motor counterclockwise until the motor flanges are encircling the cap screws in the cutting unit side plates. Tighten two (2) cap screws to secure cutting reel motor to cutting unit.

5. If cutting reel motor was removed from machine, connect reel motor cable to machine wire harness (Fig. 93):

- A. Connect two (2) reel motor cable connectors to machine wire harness.
- B. Position reel motor cable connector plate to machine frame and secure with flange nut.
- C. Position reel motor cable to bulkhead bracket on machine and tighten bulkhead nut.

6. Lubricate grease fitting on cutting unit side plate that includes reel motor.

7. After completing installation of all cutting unit motors, plug the 48 VDC battery disconnect back into the socket.

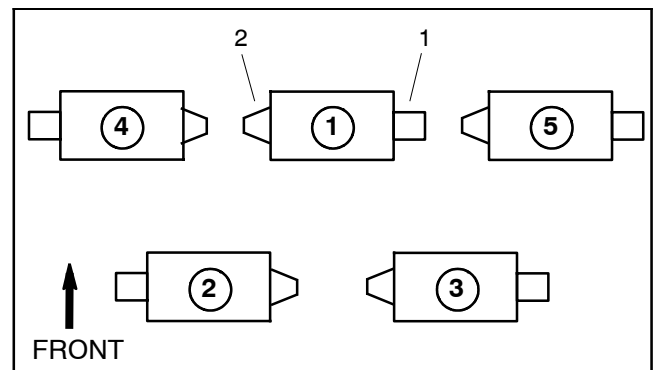


Figure 94

- 1. Reel motor location
- 2. Weight location

Cutting Reel Motor Service

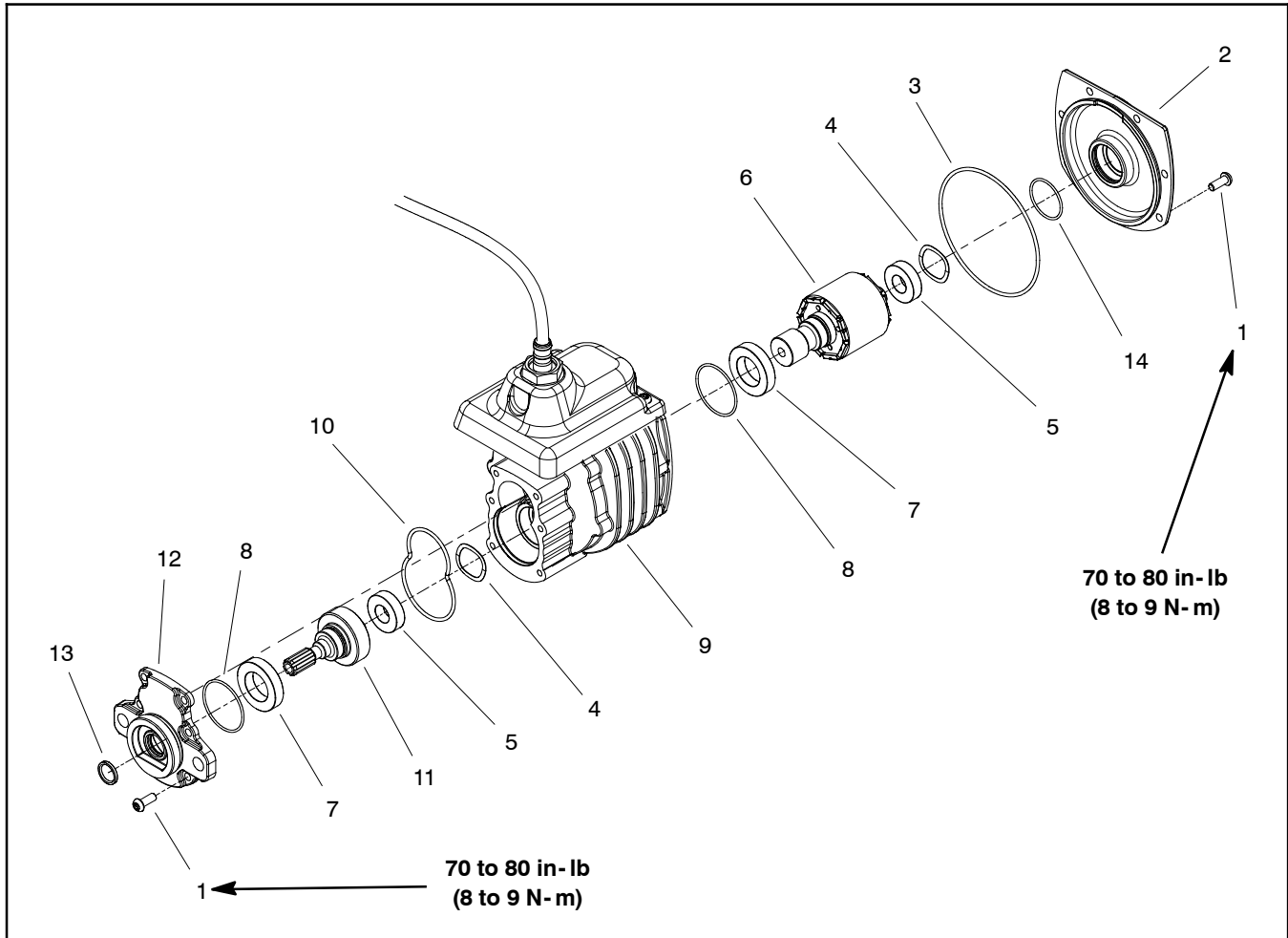


Figure 95

- | | | |
|------------------------------|--------------------------------------|-------------------|
| 1. Torx head screw (12 used) | 6. Rotor | 11. Output gear |
| 2. Motor cover | 7. Bearing (2 used) | 12. Gearbox cover |
| 3. O-ring | 8. O-ring (2 used) | 13. Shaft seal |
| 4. Wave washer (2 used) | 9. Housing/controller/cable assembly | 14. O-ring |
| 5. Bearing (2 used) | 10. O-ring | |

NOTE: If motor housing, controller or cable damage occurs, cutting reel motor replacement is necessary. These components are not available separately.

IMPORTANT: When working on the cutting reel motor, use a clean work space with a non-metal surface. The reel motor rotor includes very powerful magnets that can cause the rotor to move unexpectedly if working on a metal surface. Also, any metallic debris that gets attracted to the rotor can damage the motor after assembly.

Disassembly (Fig. 95)

1. Remove six (6) torx head screws that secure gearbox cover (item 12) to front of motor housing.
2. Carefully slide gearbox cover from front of motor.

3. Remove and discard O-rings (items 8 and 10) from gearbox cover.

4. Slide output gear assembly (items 5, 11 and 7) from motor housing. Remove wave washer (item 4).

5. Remove six (6) torx head screws that secure motor cover (item 2) to rear of motor housing. Leave cover on rotor shaft.

IMPORTANT: The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during removal. Use cutting reel motor rotor tool set (see Special Tools in this chapter) to remove rotor. Be cautious during rotor removal to prevent component damage or personal injury.

6. Use cutting reel motor rotor tool set (see Special Tools in this chapter) to carefully remove rotor assembly (items 5, 6 and 7) and motor cover (item 2) from motor housing.

7. Remove motor cover and wave washer (item 4) from rotor assembly. Remove and discard O-rings (items 14 and 3) from cover.

8. Remove and discard O-ring (item 8) from motor housing.

IMPORTANT: Make sure to not damage the gearbox cover counter bore when removing the shaft seal from the cover.

9. Carefully remove shaft seal from gearbox cover. Discard removed seal.

10. If necessary, remove bearings from output gear (item 11) and rotor (item 6). Discard bearings if removed.

11. Inspect grease in output gear area of motor housing. If grease is clean and not contaminated, it can remain in housing. If grease is contaminated, clean grease from housing and replace with 15 ml of NLGI grade 00 grease during motor assembly.

12. Inspect cutting reel motor components for wear or damage. Replace components or cutting unit motor assembly if necessary.

Assembly (Fig. 95)

1. Make sure that motor components are cleaned before assembly.

2. If bearings were removed from output gear (item 11) or rotor (item 6) install new bearings. Make sure that bearings are fully pressed onto shafts.

3. Lubricate new inner O-ring (item 8) with dielectric lubricant (see Special Tools in this chapter) and install O-ring into groove in motor housing.

IMPORTANT: The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during installation. Use cutting reel motor rotor tool set (see Special Tools in this chapter) to remove rotor. Be cautious during rotor installation to prevent component damage or personal injury.

4. Use cutting reel motor rotor tool set (see Special Tools in this chapter) to carefully install rotor assembly (items 5, 6 and 7) into motor housing.

5. Lubricate new O-rings (items 14 and 3) with dielectric lubricant (see Special Tools in this chapter) and install O-rings to grooves in motor cover. Place wave washer (item 4) in cover.

6. Carefully slide motor cover onto rotor until it contacts motor housing. Secure cover with six (6) torx head screws.

7. Make sure that rotor rotates without binding before continuing with motor assembly.

8. Place wave washer (item 4) into housing bore for output gear bearing.

9. Make sure that output gear area of motor housing has clean grease remaining in housing. If grease was cleaned from housing, install 15 ml of new NLGI grade 00 grease into housing during motor assembly.

10. Slide output gear assembly (items 5, 11 and 7) into front of housing. Make sure that output gear teeth mesh with rotor gear.

11. Install shaft seal (item 13) into gearbox cover. Press shaft seal into front cover until it is flush with the cover surface. Shaft seal should have the seal lip toward the inside of the motor (Fig. 96).

12. Lubricate new O-rings (items 8 and 10) with dielectric lubricant (see Special Tools in this chapter) and install O-rings to grooves in gearbox cover.

IMPORTANT: Make sure to not damage the shaft seal when installing the gearbox cover.

13. Carefully slide gearbox cover onto output gear shaft until it contacts motor housing. Secure cover with six (6) torx head screws.

14. Torque all torx screws (item 1) on gearbox cover and motor cover from **70 to 80 in-lb (8 to 9 N-m)**.

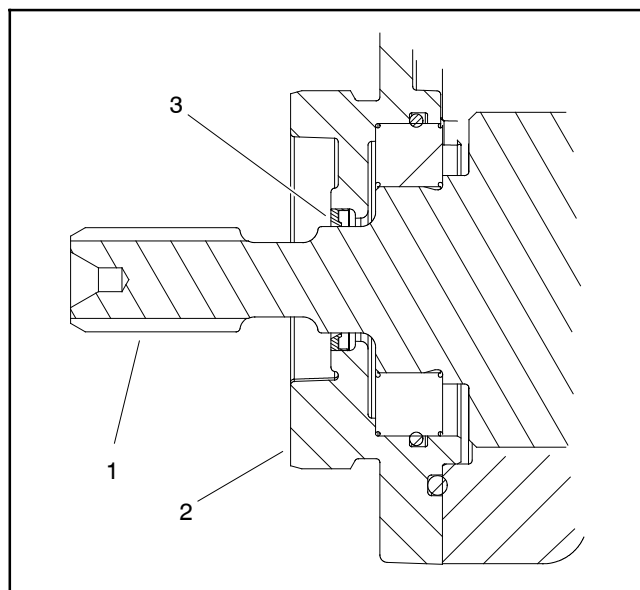


Figure 96

- 1. Output gear
- 2. Gearbox cover
- 3. Shaft seal

Motor/Generator Assembly

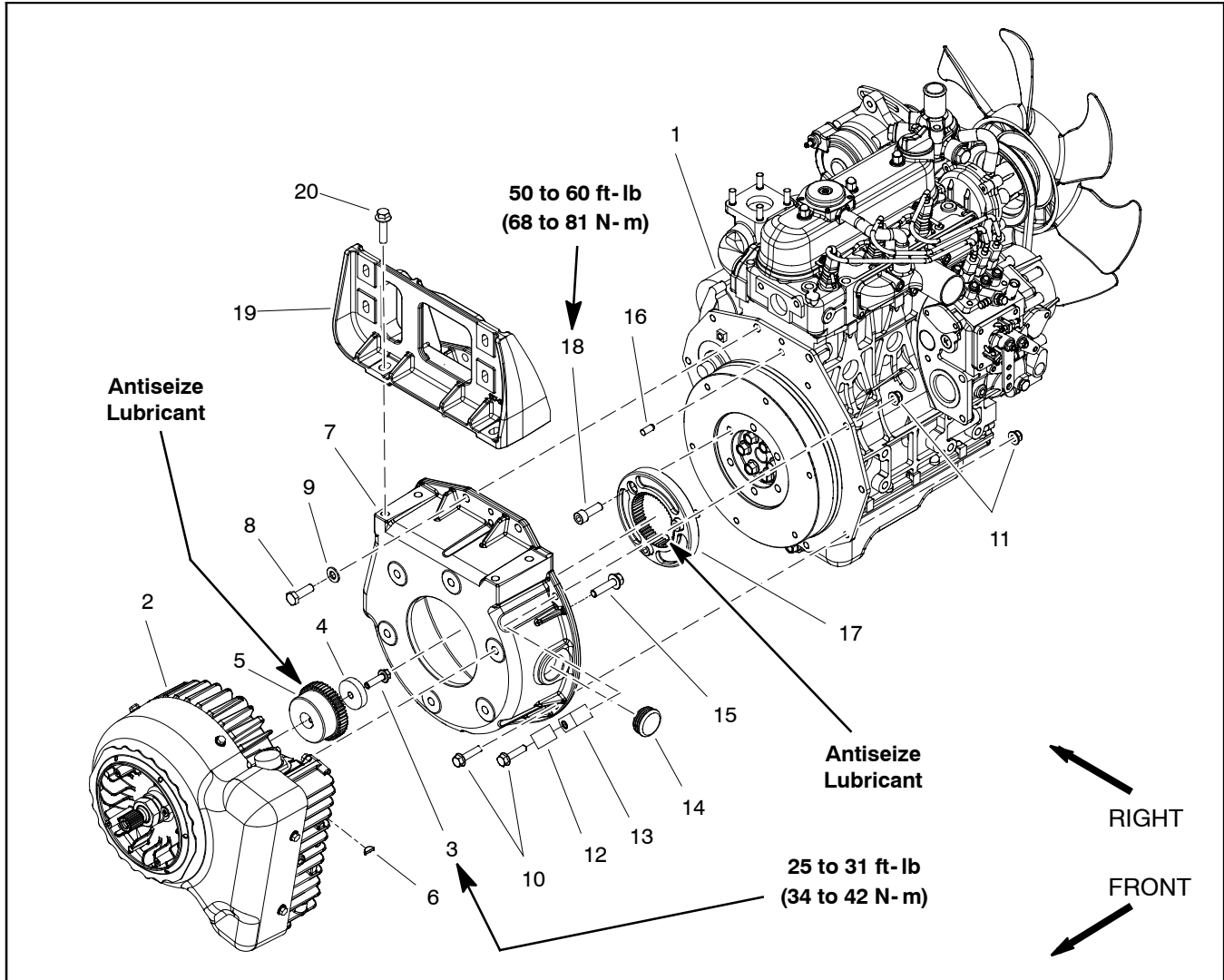


Figure 97

- | | | |
|-----------------------------|--|--------------------------------|
| 1. Diesel engine | 8. Cap screw (2 used) | 15. Flange head screw (6 used) |
| 2. Motor/generator assembly | 9. Flat washer (2 used) | 16. Dowel pin (2 used) |
| 3. Flange head screw | 10. Flange head screw (7 used) | 17. Coupler flange |
| 4. Collar | 11. Flange nut (2 used) | 18. Socket head screw (3 used) |
| 5. Coupler hub | 12. R-clamp (for generator wire harness) | 19. Muffler bracket |
| 6. Woodruff key | 13. Clamp (for fuel return hose) | 20. Flange head screw (4 used) |
| 7. Engine bellhousing | 14. Caplug | |

NOTE: If electrical problems exist with the motor/generator assembly, a fault should have occurred that would be indicated by a fault code on the InfoCenter Display. Before considering that motor/generator service work is necessary, check for any existing fault codes that indicate problems with the motor/generator (see Fault Codes in the Troubleshooting section of this chapter).

NOTE: The 48 VDC motor/generator is secured to the engine bellhousing with six (6) flange head screws. Access to these screws requires the bellhousing and motor/generator to be removed from the engine as an assembly before removing the motor/generator from the bellhousing.


Removal (Fig. 97)

1. Park machine on a level surface, lower cutting units, stop engine, apply parking brake and remove key from ignition switch.
2. Separate system components from the 48 VDC battery pack by unplugging the 48 VDC battery disconnect. (see 48 VDC Battery Disconnect in the General Information section of this chapter). This will prevent unexpected 48 VDC system component operation.
3. Raise and support hood and operator seat.

4. Disconnect hydraulic pump drive shaft from 48 VDC motor/generator output shaft (see Hydraulic Pump Drive Shaft in the Service and Repairs section of Chapter 4 - Hydraulic System). Position drive shaft away from engine.

5. Remove exhaust muffler from machine (see Exhaust System in the Service and Repairs section of Chapter 3 - Kubota Diesel Engine).

6. Disconnect wire harness connector from motor/generator assembly.

	CAUTION
Support motor/generator and bellhousing assembly when removing it to prevent it from falling and causing personal injury. Assembly weighs approximately 69 pounds (31 kg).	

7. For assembly purposes, note locations of r-clamps on bellhousing (Fig. 98). Support motor/generator and bellhousing to prevent the assembly from falling or shifting.

8. Remove fasteners that secure bellhousing to engine plate. Position r-clamps with wire harness and fuel return hose away from bellhousing.

IMPORTANT: Make sure to not damage the motor/generator, fuel lines, hydraulic hoses, electrical harness, control cables or other parts while removing the motor/generator and bellhousing assembly.

9. Carefully move motor/generator and bellhousing assembly away from engine so that motor/generator coupler hub (item 5) slides out of flywheel coupler flange (item 17). Once motor/generator coupler is removed from flange, lift motor/generator and bellhousing assembly from machine.

10. Note location of two (2) dowel pins (item 16) in engine plate for assembly purposes.

11. Remove six (6) flange head screws that secure motor/generator to bellhousing. Remove motor/generator from bellhousing.

12. If necessary, remove flange head screw and spacer that secure motor/generator coupler hub to motor/generator input shaft. Use suitable puller to remove coupler hub from motor/generator shaft. Locate and retrieve woodruff key from motor/generator shaft.

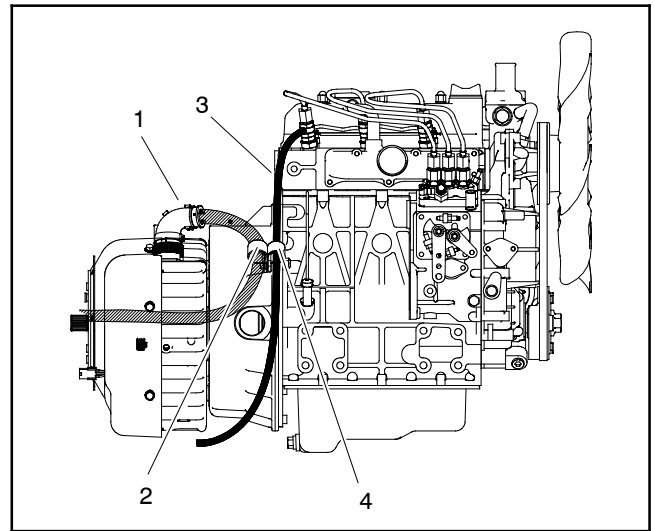


Figure 98

- | | |
|------------------------|---------------------|
| 1. Generator connector | 3. Fuel return hose |
| 2. R-clamp | 4. R-clamp |

Installation (Fig. 97)

1. If removed, install coupler hub to motor/generator input shaft:

IMPORTANT: Before coupler hub is installed to motor/generator input shaft, thoroughly clean tapers of coupler hub and motor/generator input shaft. Make sure that tapers are free of grease, oil and dirt. DO NOT use antiseize lubricant when installing coupler hub.

A. Thoroughly clean tapers on motor/generator input shaft and coupler hub bore.

B. Place woodruff key in motor/generator shaft slot and then install the coupler hub onto the shaft.

C. Secure coupler hub to motor/generator shaft with collar and flange head screw. Torque screw from **25 to 31 ft-lb (34 to 42 N-m)**.

2. Position motor/generator to bellhousing and secure with six (6) flange head screws. Torque screws from **50 to 60 ft-lb (68 to 81 N-m)**.

3. Apply antiseize lubricant to splines of coupler hub on motor/generator shaft and coupler flange on flywheel.

4. Make sure that dowel pins (item 16) are properly positioned in bellhousing.



CAUTION

Support motor/generator and bellhousing assembly when installing it to prevent it from falling and causing personal injury. Assembly weighs approximately 69 pounds (31 kg).

IMPORTANT: Make sure to not damage the motor/generator, fuel lines, hydraulic hoses, electrical harness, control cables or other parts while installing the motor/generator and bellhousing assembly.

5. Lower motor/generator and bellhousing assembly toward engine, engage motor/generator coupler hub (item 5) into flywheel coupler flange (item 17) and slide bellhousing to engine plate.

6. Secure bellhousing to engine plate with removed fasteners. Make sure that r-clamps are in locations noted during disassembly (Fig. 98). R-clamp that secures motor/generator wire harness connection should cover red tape on harness.

7. Connect wire harness connector to motor/generator assembly.

8. Connect hydraulic pump drive shaft to motor/generator output shaft (see Hydraulic Pump Drive Shaft in the Service and Repairs section of Chapter 4 - Hydraulic System). Make sure that air intake shroud fits properly to motor/generator cover and also that air intake hose is secured to intake shroud.

9. Install exhaust muffler to machine (see Exhaust System in the Service and Repairs section of Chapter 3 - Kubota Diesel Engine).

10. After completing installation of the motor/generator assembly, plug the 48 VDC battery disconnect back into the socket.

11. Lower and secure hood and operator seat.

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Motor/Generator Assembly Service

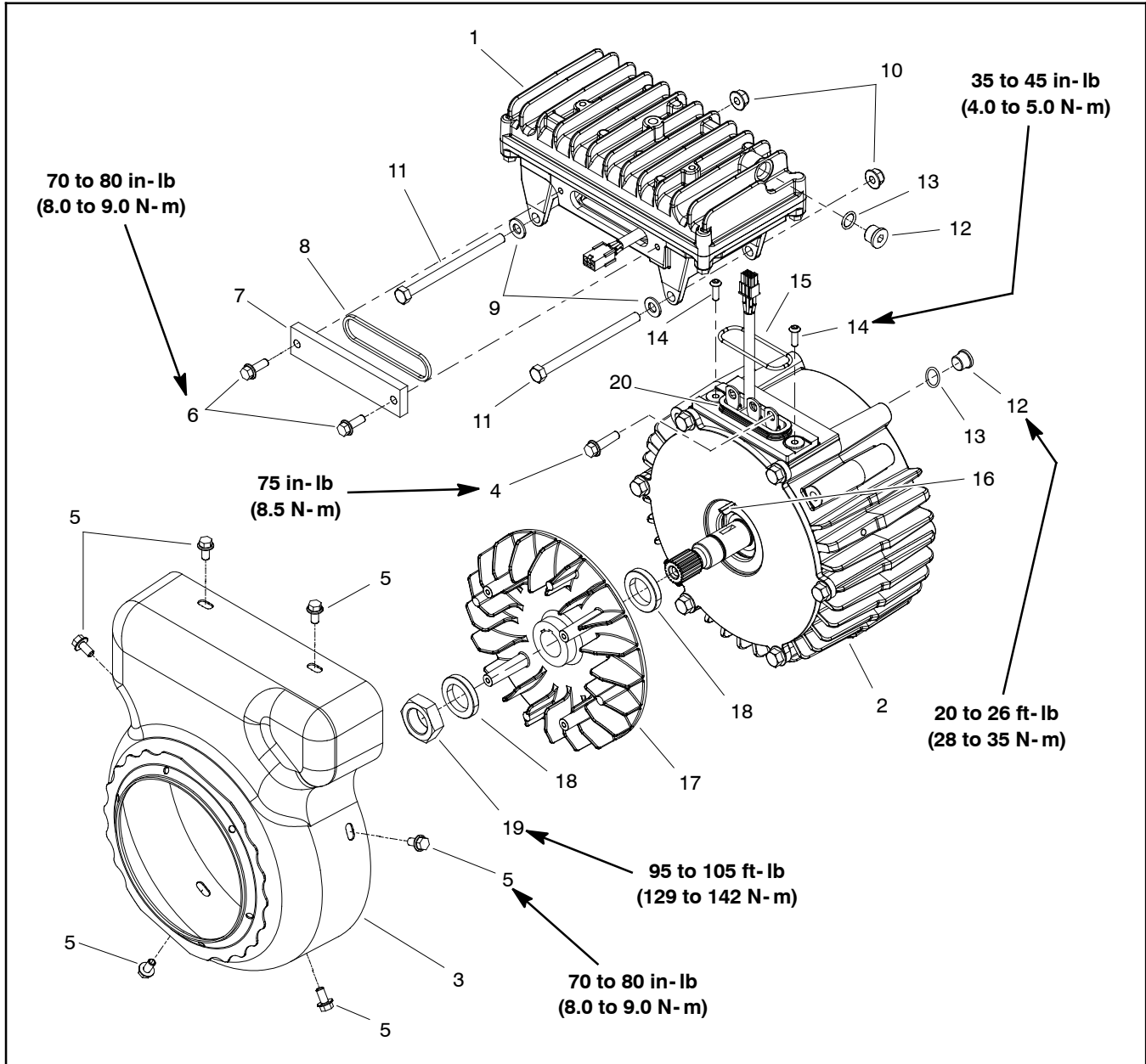


Figure 99

- | | | |
|-------------------------------|--------------------------------|-------------------------|
| 1. Controller assembly | 8. Cover gasket | 15. O-ring |
| 2. Motor/generator assembly | 9. Flat washer (2 used) | 16. Woodruff key |
| 3. Motor/generator cover | 10. Flange nut (2 used) | 17. Motor/generator fan |
| 4. Flange head screw (3 used) | 11. Cap screw (2 used) | 18. Spacer (2 used) |
| 5. Washer head screw (6 used) | 12. Plug (2 used) | 19. Nut |
| 6. Washer head screw (2 used) | 13. O-ring | 20. Isolator |
| 7. Access cover | 14. Button head screw (2 used) | |

IMPORTANT: When working on the motor/generator, use a clean work space with a non-metal surface. The motor/generator rotor includes very powerful magnets that can cause the rotor to move unexpectedly if working on a metal surface. Also, any metallic debris that gets attracted to the rotor can damage the motor/generator after assembly.

Disassembly (Fig. 99)

1. Remove motor/generator cover (item 3) from motor/generator assembly.
2. Remove access cover (item 7) and cover gasket from controller. Discard cover gasket.
3. Carefully remove motor/generator and controller harness connectors from controller opening. Note position of connectors and wire harnesses for assembly purposes. Unplug connectors.
4. Remove three (3) flange head screws (item 4) that secure motor/generator stator conductors to controller connectors.
5. Remove cap screws (item 11), flat washers (item 9) and flange nuts (item 10) that secure controller to motor/generator assembly. Lift controller from motor/generator. Remove and discard O-ring (item 15).

NOTE: If controller (item 1) damage exists, controller replacement is necessary. Internal controller components are not available separately.

6. Remove nut (item 19) that secures fan to motor/generator shaft.
7. Remove motor/generator fan and two (2) spacers from motor/generator shaft. Locate and retrieve woodruff key.
8. Remove internal motor/generator assembly components (Fig. 100):

- A. Remove six (6) flange head screws that secure cover to housing. Leave cover on rotor shaft.

IMPORTANT: The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during removal. Use generator rotor tool set (see Special Tools in this chapter) to remove rotor. Be cautious during rotor removal to prevent component damage or personal injury.

- B. Use generator rotor tool set (see Special Tools in this chapter) to carefully remove rotor assembly including cover from housing. Follow removal procedure listed in Special Tool section.

- C. Remove cover from rotor assembly. Remove O-rings and wave washer from cover. Discard O-rings.

- D. Remove and discard O-ring from housing groove in bearing bore.

- E. If necessary, remove bearings from rotor. Discard bearings if removed.

- F. If necessary, remove isolator from housing assembly.

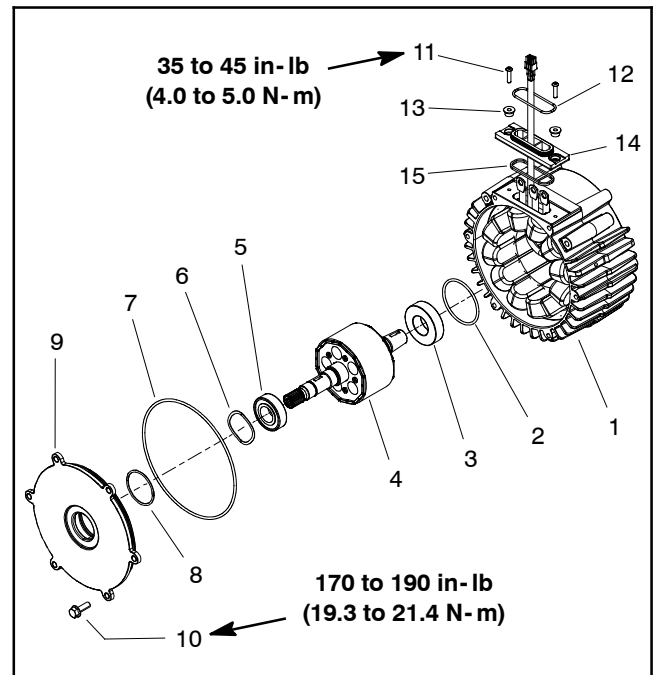


Figure 100

- | | |
|----------------------------|---------------------------|
| 1. Housing/stator assembly | 9. Cover |
| 2. O-ring | 10. Flange screw (6 used) |
| 3. Bearing | 11. Screw (2 used) |
| 4. Rotor assembly | 12. O-ring |
| 5. Bearing | 13. Spacer (2 used) |
| 6. Wave washer | 14. Isolator |
| 7. O-ring | 15. Gasket |
| 8. O-ring | |

9. Inspect rotor assembly for wear or damage. Also, inspect motor/generator housing/stator assembly for evidence of damage.

NOTE: If motor/generator housing/stator damage exists, motor/generator assembly replacement is necessary. The motor/generator housing and stator are not available separately.

Assembly (Fig. 99)

1. Make sure that all motor/generator components are cleaned before assembly.
2. Install internal motor/generator assembly components (Fig. 100):
 - A. If bearings were removed from rotor assembly, install new bearings onto rotor shaft. Make sure that new bearings are fully pressed onto rotor shaft.
 - B. If isolator was removed, lubricate new gasket with dielectric lubricant (see Special Tools in this chapter) and install to isolator. Fit isolator to housing assembly making sure that stator conductors and stator harness are correctly positioned in isolator. Secure isolator with spacers and screws. Torque screws from **35 to 45 in-lb (4.0 to 5.0 N-m)**.

C. Lubricate new O-ring (item 2) with dielectric lubricant (see Special Tools in this chapter) and install into groove in housing bearing bore.

IMPORTANT: The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during installation. Use generator rotor tool set (see Special Tools in this chapter) to install rotor. Be cautious during rotor installation to prevent component damage or personal injury.

D. Use generator rotor tool set (see Special Tools in this chapter) to carefully install rotor assembly into housing. Make sure that rotor bearing is fully seated in housing.

E. Lubricate new O-rings (items 7 and 8) with dielectric lubricant (see Special Tools in this chapter) and install O-rings into grooves in cover. Place wave washer in cover bearing bore.

F. Install cover to housing and secure with six (6) flange head screws. Torque screws from **170 to 190 in-lb (19.3 to 21.4 N-m)**.

G. Make sure that rotor rotates before continuing with motor/generator assembly.

3. Install motor/generator fan:

A. Position woodruff key (item 16) into slot on rotor shaft.

B. Slide spacer, motor/generator fan and then second spacer onto motor/generator shaft.

C. Secure fan to motor/generator shaft with nut (item 19). Torque nut from **95 to 105 ft-lb (129 to 142 N-m)**.

4. Lubricate new O-ring with dielectric lubricant (see Special Tools in this chapter) and install into groove on isolator.

5. Install controller onto motor/generator:

A. Lower controller onto motor/generator and route both controller and motor/generator harness connectors out opening in controller.

IMPORTANT: When securing stator conductors to controller connectors, make sure that flange head screws do not pinch electrical harnesses.

B. Loosely install three (3) flange head screws (item 4) that secure motor/generator stator conductors to controller connectors. Make sure that controller and motor/generator harnesses are positioned away from the screws.

C. Secure controller with cap screws (item 11), flat washers (item 9) and flange nuts (item 10).

D. Torque three (3) flange head screws (item 4) to **75 in-lb (8.5 N-m)**.

E. Pack controller harness connector with dielectric lubricant (see Special Tools in this chapter). Plug motor/generator connector into controller connector. Insert harnesses and connectors to the right side of the three (3) terminals in the controller.

6. Lubricate new cover gasket (item 8) with dielectric lubricant (see Special Tools in this chapter). Install gasket into groove in access cover (item 7) and then install cover to controller. Secure cover with two (2) washer head screws. Torque screws from **70 to 80 in-lb (8.0 to 9.0 N-m)**.

7. Install motor/generator cover (item 3) to motor/generator assembly and secure with washer head screws. Torque screws from **70 to 80 in-lb (8.0 to 9.0 N-m)**.



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Specifications


Item	Description
Front Tire Pressure (26.5 x 14.0 - 12, 4 ply, tubeless)	12 to 15 PSI (83 to 103 kPa)
Rear Tire Pressure (20 x 12.0 - 10, 4 ply, tubeless)	12 to 15 PSI (83 to 103 kPa)
Wheel Lug Nut Torque	70 to 90 ft- lb (95 to 122 N- m)
Wheel Motor/Wheel Hub Lock Nut Torque	315 to 385 ft- lb (428 to 522 N- m)

General Information

Traction Unit Operator’s Manual

The Traction Unit Operator’s Manual provides information regarding the operation, general maintenance and maintenance intervals for your Reelmaster machine. Refer to that publication for additional information when servicing the machine.

48 VDC Battery Disconnect


CAUTION

Before installing, removing or servicing components in the 48 VDC system (e.g. cutting unit motors, motor/generator), separate the 48 VDC battery disconnect. This will prevent unexpected operation of 48 VDC system components.

The 48 VDC battery disconnect is attached to the right frame rail under the operator seat (Fig. 1). Unplug the disconnect to make sure that 48 VDC components do not operate unexpectedly. Apply dielectric grease to the contact surfaces of the battery disconnect and plug the battery disconnect back in after service to the 48 VDC system is completed.

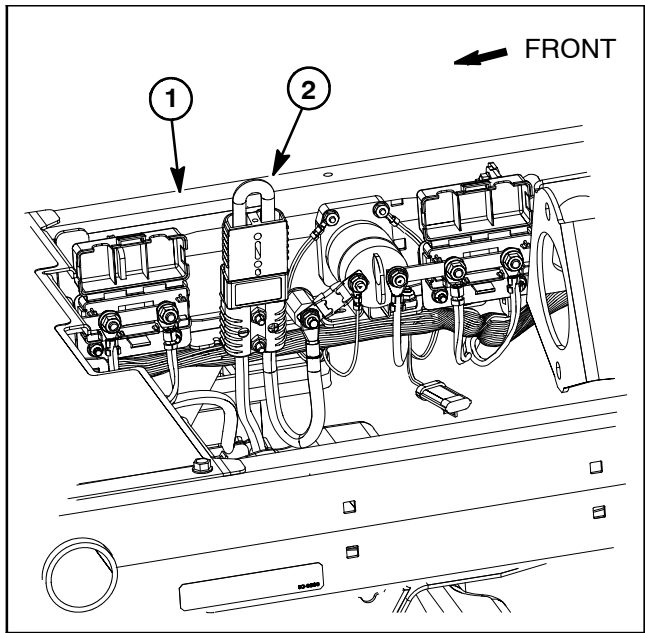


Figure 1

- 1. RH frame rail
- 2. 48V battery disconnect

Special Tools

Order Toro special tools from your Toro Distributor.

Wheel Hub Puller

The wheel hub puller allows safe removal of the front wheel hub from the wheel motor shaft. If machine is equipped with optional CrossTrax™ Kit, this wheel hub puller is needed for removing rear wheel hub from the rear wheel motor.

Toro Part Number: **TOR6004**



Figure 2

Service and Repairs

Wheels

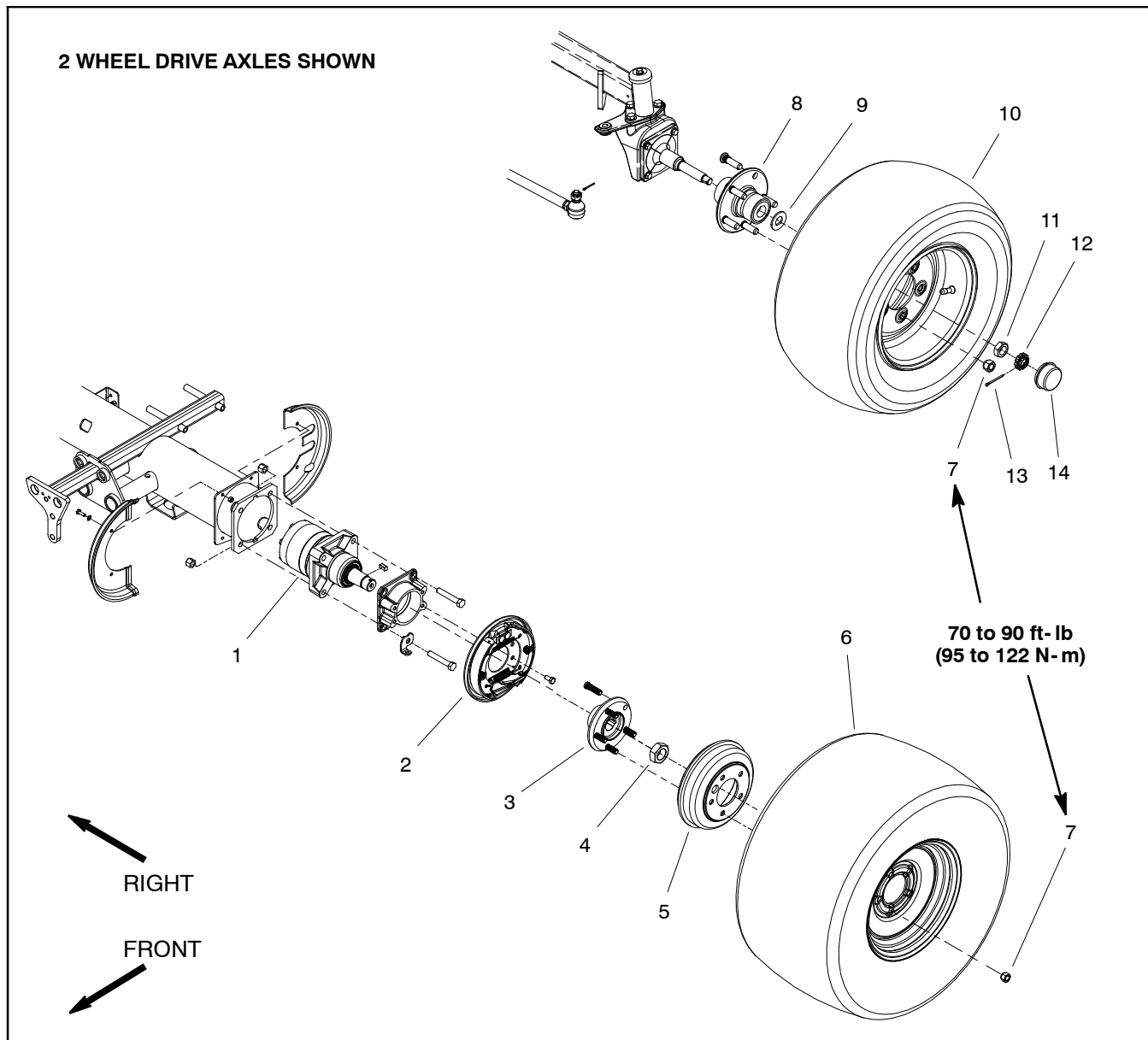



Figure 3

- | | | |
|----------------------|-------------------------------|----------------|
| 1. Front wheel motor | 6. Front wheel | 11. Jam nut |
| 2. Brake assembly | 7. Lug nut (5 used per wheel) | 12. Retainer |
| 3. Front wheel hub | 8. Rear wheel hub | 13. Cotter pin |
| 4. Lock nut | 9. Spindle washer | 14. Dust cap |
| 5. Brake drum | 10. Rear wheel | |

Removal (Fig. 3)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.
2. Chock wheels to prevent machine from shifting.
3. Loosen, but do not remove, wheel lug nuts.

 CAUTION
<p>When changing tires, attachments or performing other service, use correct hoists, jacks and jack stands. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or other appropriate load holding devices to support the raised machine. If the machine is not properly supported, the machine may move or fall, which may result in personal injury.</p>

4. Using a jack, raise machine so wheel is off ground (see Jacking Instructions in Chapter 1 - Safety). Support machine with jack stands.
5. Remove wheel lug nuts and then remove wheel from machine.

Installation (Fig. 3)

1. Install wheel and secure with five (5) wheel lug nuts.
2. Lower machine to ground.

 WARNING
<p>Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.</p>

3. Torque wheel lug nuts evenly in a crossing pattern from **70 to 90 ft-lb (95 to 122 N-m)**.

Steering Column

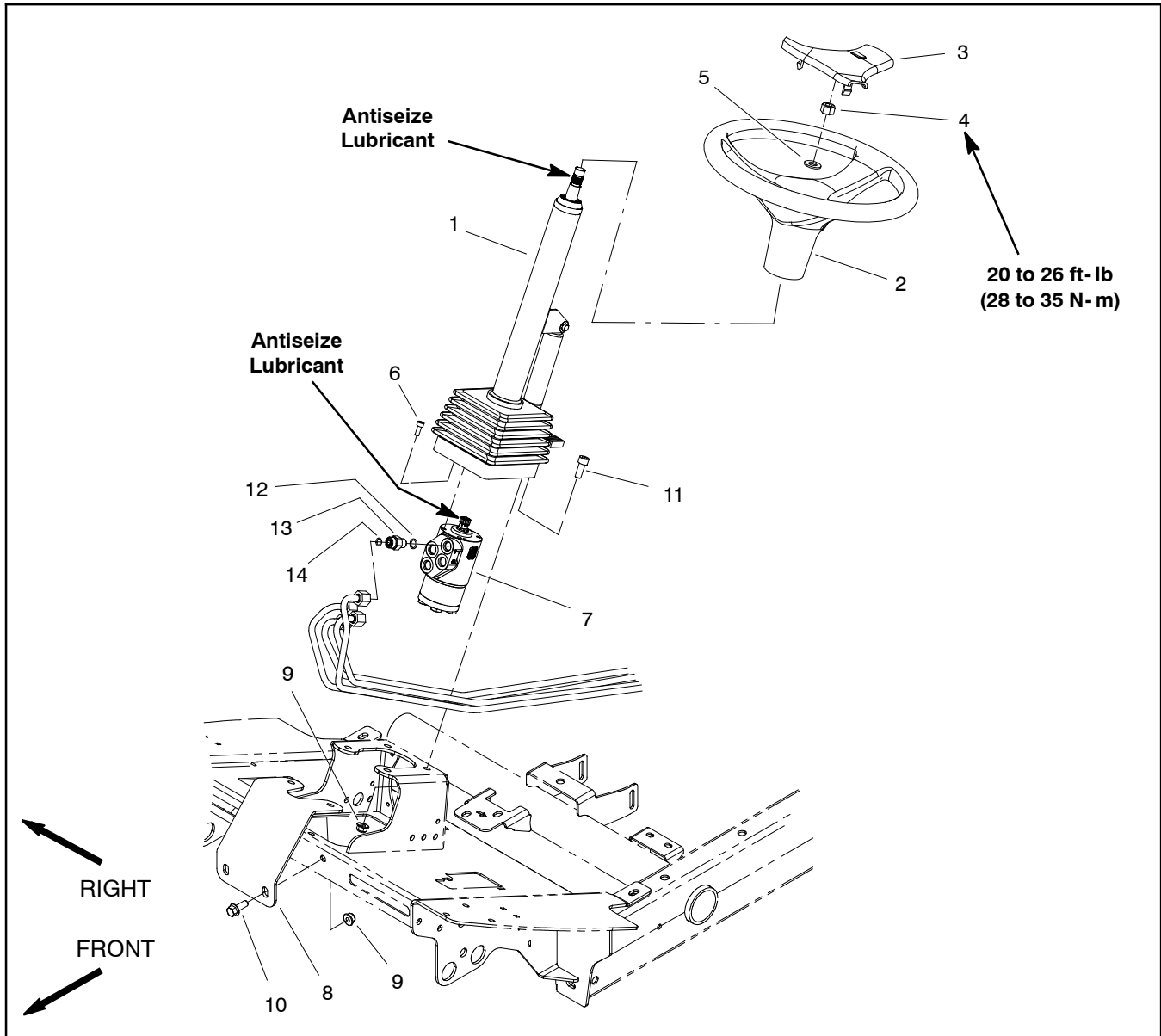


Figure 4

- | | | |
|-------------------------|--------------------------------|--------------------------------|
| 1. Steering column | 6. Socket head screw (4 used) | 11. Socket head screw (4 used) |
| 2. Steering wheel | 7. Steering control valve | 12. O-ring |
| 3. Steering wheel cover | 8. Column brace | 13. Hydraulic fitting (4 used) |
| 4. Lock nut | 9. Flange nut (6 used) | 14. O-ring |
| 5. Flat washer | 10. Flange head screw (2 used) | |

Removal (Fig. 4)

1. Park the machine on a level surface, engage the parking brake, lower the cutting units and stop the engine. Remove the key from the ignition switch.

2. Remove cover from steering wheel by carefully prying up on one of the cover spokes.

3. Remove lock nut and flat washer that secure steering wheel to steering column.

4. Use a suitable puller to remove steering wheel from steering column.

5. Remove platform shroud from machine to allow access to steering column fasteners (Fig. 5).

A. Remove cover plate from platform.

B. Remove fasteners that secure platform shroud to machine and remove platform shroud

C. Retrieve two (2) rubber bushings and spacers.

6. Slide rubber bellows up steering column to allow access to fasteners that secure steering column to machine.

7. Support steering control valve to prevent it from shifting during steering column removal.

8. Loosen and remove four (4) socket head screws (item 6) that secure steering control valve to steering column.

9. Loosen and remove four (4) socket head screws (item 11) and flange nuts (item 9) that secure steering column to machine.

10. Slide steering column assembly from steering control valve and machine.

11. Disassemble steering column assembly as needed using Figure 6 as a guide.

Installation (Fig. 4)

1. Assemble steering column using Figure 6 as a guide. After assembly, make sure that release pin on end of cylinder shaft is positioned against the pedal. Jam nut on cylinder shaft can be used to adjust location of release pin.

2. Apply antiseize lubricant to input shaft of steering control valve.

3. Slide steering column onto steering control valve. Secure steering column in place with four (4) socket head screws (item 11) and flange nuts (item 9).

4. Secure steering control valve to steering column with four (4) socket head screws (item 6).

5. Slide rubber bellows to bottom of steering column.

6. Place rubber bushings and spacers into holes of platform shroud (Fig. 5). Position platform shroud in place and secure with removed fasteners.

7. Thoroughly clean tapered surfaces of steering wheel and steering column.

8. Apply antiseize lubricant to splines of steering column taking care to keep antiseize lubricant from column taper. Slide steering wheel onto steering column.

9. Secure steering wheel to steering column with flat washer and lock nut. Torque hex nut from **20 to 26 ft-lb (28 to 35 N-m)**.

10. Install steering wheel cover to steering wheel.

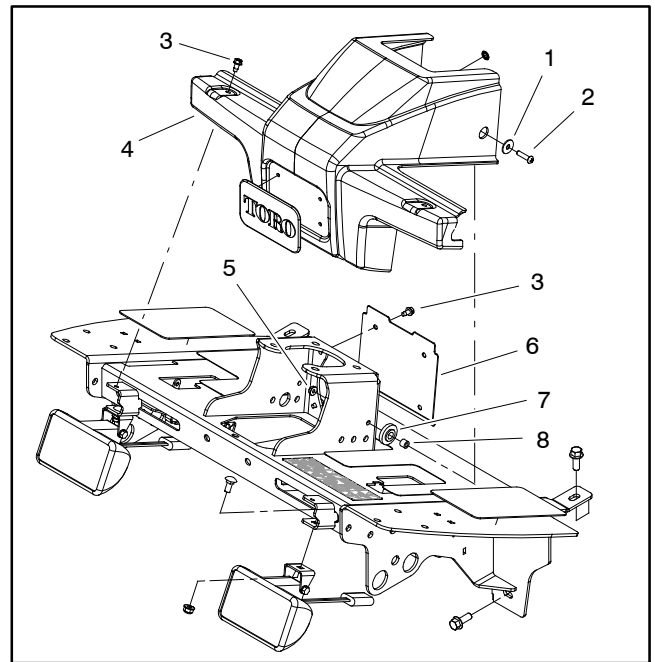


Figure 5

- | | |
|--------------------|----------------------|
| 1. Washer (2 used) | 5. Lock nut (2 used) |
| 2. Screw (2 used) | 6. Cover plate |
| 3. Screw (6 used) | 7. Bushing (2 used) |
| 4. Platform shroud | 8. Spacer (2 used) |

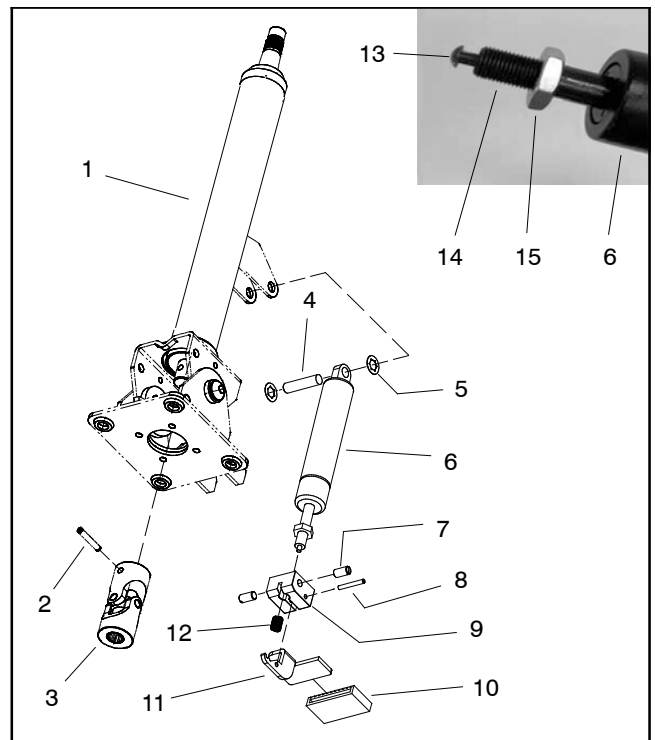


Figure 6

- | | |
|-------------------------|--------------------|
| 1. Steering column | 9. Pedal block |
| 2. Pin | 10. Pedal cover |
| 3. Universal joint | 11. Pedal |
| 4. Pin | 12. Spring |
| 5. Lock washer (2 used) | 13. Release pin |
| 6. Cylinder | 14. Cylinder shaft |
| 7. Bolt (2 used) | 15. Jam nut |
| 8. Pin | |

Brake Service

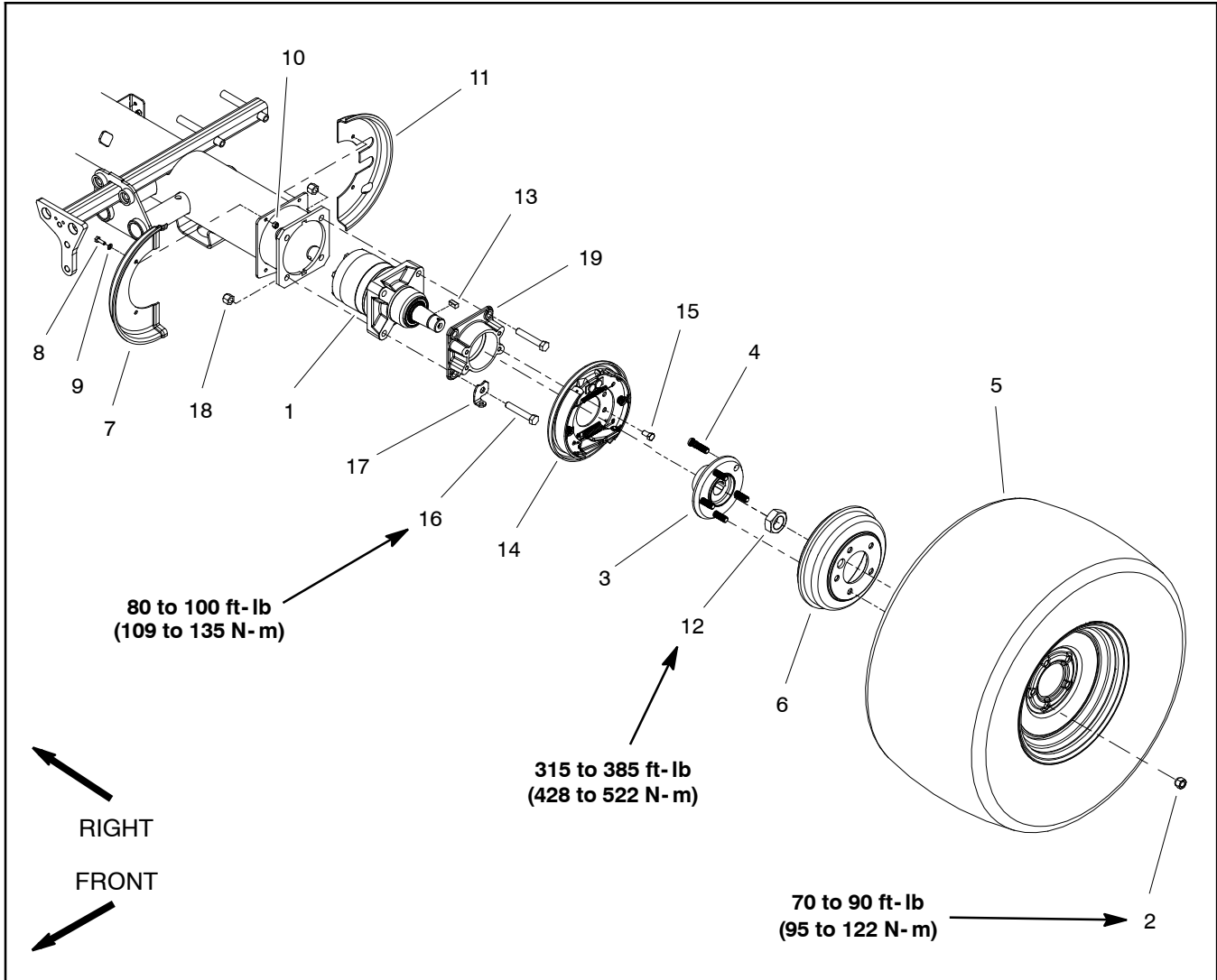


Figure 7

- | | | |
|----------------------------------|------------------------------------|---------------------------------------|
| 1. Wheel motor (LH shown) | 8. Cap screw (2 used per shield) | 14. Brake assembly (LH shown) |
| 2. Lug nut (5 used per wheel) | 9. Flat washer (2 used per shield) | 15. Cap screw (4 used per brake assy) |
| 3. Wheel hub | 10. Lock nut (2 used per shield) | 16. Cap screw (4 used per motor) |
| 4. Wheel stud (5 used per wheel) | 11. Rear wheel shield (LH shown) | 17. Spring clip (LH shown) |
| 5. Wheel assembly | 12. Lock nut | 18. Lock nut (4 used per motor) |
| 6. Brake drum | 13. Square key | 19. Brake adapter |
| 7. Front wheel shield (2 used) | | |

Removal (Fig. 7)

1. Park the machine on a level surface, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Chock wheels to prevent machine from shifting.
3. Loosen, but do not remove, lock nut (item 12) from wheel motor shaft.
4. Remove front wheel assembly (see Wheels in this section). Make sure to support raised machine with appropriate jack stands.
5. Make sure parking brake is disengaged.

NOTE: Clevis pin that secures brake cable to brake actuator lever is secured with extension spring (shown in Fig. 8).

6. Remove extension spring from clevis pin that secures brake cable to brake actuator lever (Fig. 8). Remove clevis pin and position brake cable away from brake actuator lever.

7. Remove brake drum.

IMPORTANT: DO NOT hit wheel hub, puller or wheel motor with a hammer during wheel hub removal or installation. Hammering may cause damage to the wheel motor.

8. Make sure that lock nut on wheel motor shaft is loose. Use hub puller (see Special Tools in this chapter) to loosen wheel hub from wheel motor shaft.

9. Remove lock nut and wheel hub from wheel motor shaft. Locate and retrieve square key.

NOTE: If desired, the complete brake assembly can be removed from the machine for disassembly (see step 12).

10. Remove upper and lower shoe springs from brake shoes.

11. Remove shoe hold down cups and hold down springs. Remove brake shoes and hold down pins from backing plate.

12. If necessary, remove brake backing plate from machine by loosening and removing four (4) cap screws that secure backing plate to brake adapter.

Installation (Fig. 7)

1. Remove rust and debris from all brake parts with a wire brush prior to installation. Clean all parts. Inspect brake shoe contact surfaces of the brake drum for excessive wear. Replace any worn or damaged brake parts.

Reelmaster 5010-H

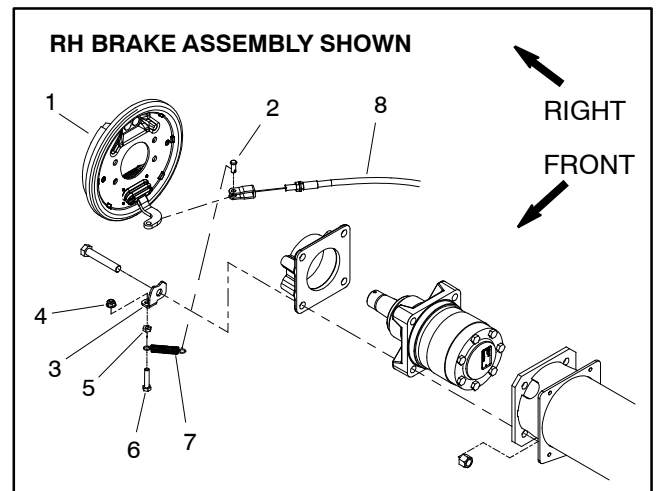


Figure 8

- | | |
|-------------------|---------------------|
| 1. Brake assembly | 5. Jam nut |
| 2. Clevis pin | 6. Cap screw |
| 3. Spring clip | 7. Extension spring |
| 4. Flange nut | 8. Brake cable |

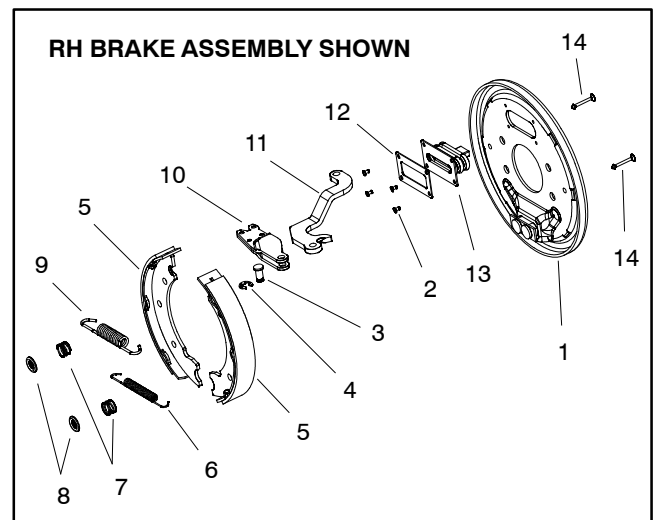


Figure 9

- | | |
|----------------------|----------------------|
| 1. Backing plate | 8. Hold down cup |
| 2. Rivet (4 used) | 9. Upper shoe spring |
| 3. Clevis pin | 10. Brake actuator |
| 4. Retaining ring | 11. Actuator lever |
| 5. Brake shoe | 12. Back-up plate |
| 6. Lower shoe spring | 13. Boot |
| 7. Hold down spring | 14. Hold down pin |

2. If backing plate was removed from machine, secure backing plate to brake adapter with four (4) cap screws.

3. Lightly lubricate brake shoe pivot points with general purpose grease.

4. Position one brake shoe to the backing plate. Install brake hold down pin and secure with hold down spring and cup. Repeat for second brake shoe.

5. Install upper and lower shoe springs to brake shoes. Make sure that brake shoes are properly positioned to pivot and actuator points.

IMPORTANT: Before wheel hub is installed, thoroughly clean tapers of wheel hub and wheel motor shaft. Make sure that tapers are free of grease, oil and dirt. DO NOT use antiseize lubricant when installing wheel hub.

6. Mount square key in the wheel motor shaft, then install the wheel hub onto the wheel motor shaft.
7. Secure wheel hub onto the wheel motor shaft with lock nut (item 12).
8. Install brake drum.
9. Position brake cable end to brake actuator lever (Fig. 8). Secure brake cable clevis to brake actuator lever with clevis pin and extension spring.
10. Install front wheel assembly (see Wheels in this section).

11. Check and adjust brakes.

12. Lower machine to ground.

13. Torque wheel lug nuts evenly in a crossing pattern from **70 to 90 ft-lb (95 to 122 N-m)**. Torque lock nut (item 12) that secures wheel hub from **315 to 385 ft-lb (428 to 522 N-m)**.



CAUTION

After servicing the brakes, always check the brakes in a wide open, level area that is free of other persons and obstructions.

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Rear Wheel Bearings (2 Wheel Drive)

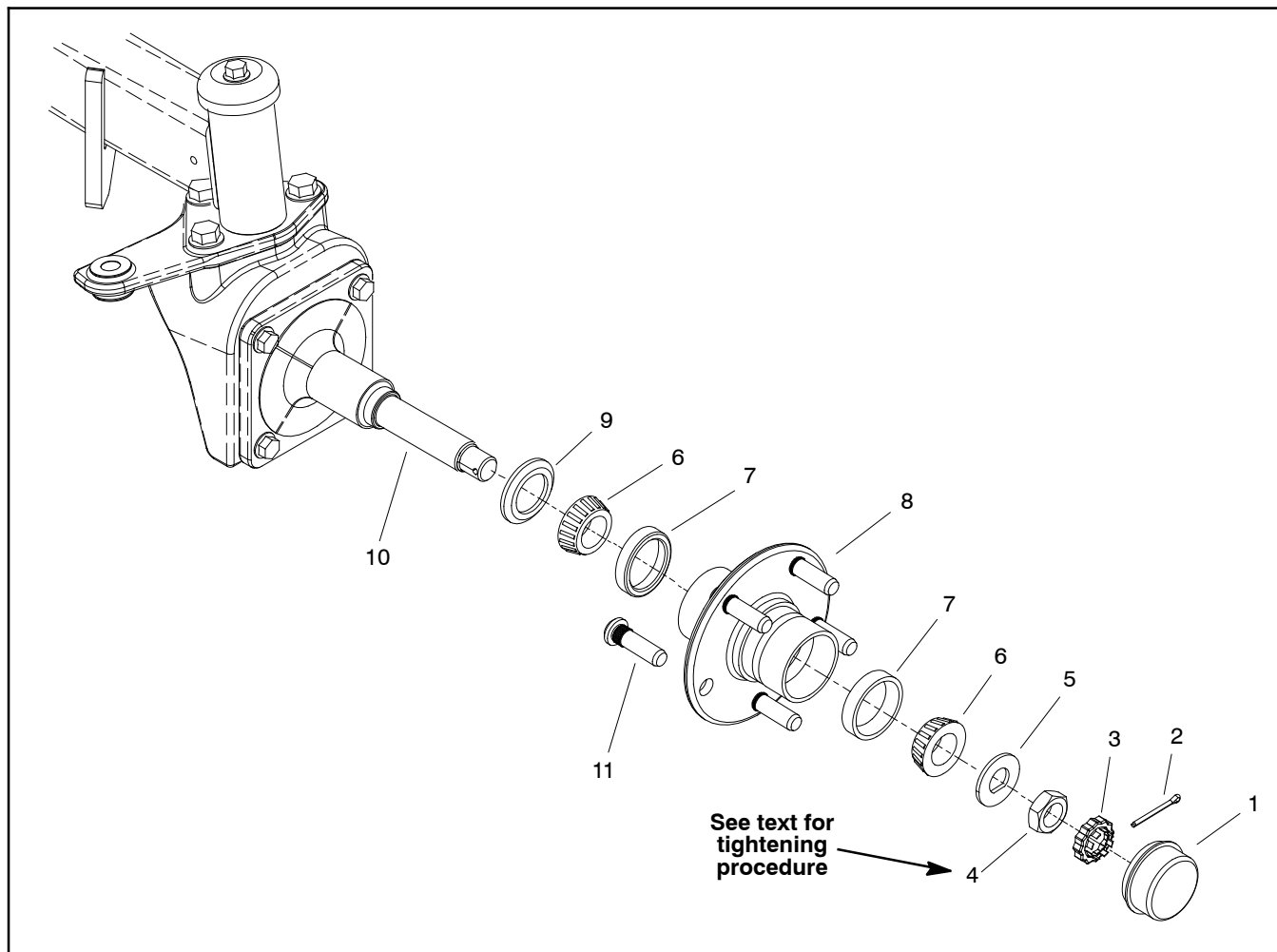


Figure 10

- 1. Dust cap
- 2. Cotter pin
- 3. Retainer
- 4. Jam nut

- 5. Spindle washer
- 6. Bearing cone
- 7. Bearing cup
- 8. Wheel hub

- 9. Seal
- 10. Spindle
- 11. Wheel stud (5 used)

Disassembly (Fig. 10)

1. Chock front wheels to prevent machine from shifting.
2. Remove rear wheel (see Wheels in this section). Make sure to support machine with jack stands.
3. Remove the dust cap from the wheel hub.
4. Remove the cotter pin, retainer, jam nut and spindle washer. Slide the wheel hub from the spindle shaft.
5. Pull the seal out of the wheel hub. Discard seal.
6. Remove the bearing cones from both sides of the wheel hub. Clean the bearings in solvent. Make sure the bearings are in good operating condition. Clean the inside of the wheel hub. Check the bearing cups for wear, pitting or other damage. Replace worn or damaged parts.

Assembly (Fig. 10)

1. If bearing cups were removed from the wheel hub, press new cups into the hub until they seat against the shoulder of the hub.

IMPORTANT: The lip of the seal must be toward the bearing. The seal should be pressed in so it is flush with the end of the wheel hub.

2. Pack both bearings with grease. Install one bearing into the bearing cup on inboard side of the wheel hub. Lubricate the inside of a new seal and press it into the wheel hub with the seal lip toward the bearing.

3. Fill wheel hub cavity between bearings approximately 50% full of grease. Position remaining bearing into the outer bearing cup.
4. Slide the wheel hub assembly onto the spindle shaft and secure it in place with the spindle washer and jam nut. **DO NOT** fully tighten the nut or install the cotter pin.
5. While rotating the wheel hub by hand, torque the jam nut from 75 to 100 in-lb (8.5 to 11.3 N-m) to set the bearings. Then, loosen the nut until the hub has endplay.
6. While rotating the wheel hub by hand, torque the jam nut from **15 to 20 in-lb (1.7 to 2.3 N-m)**. After tightening, make sure that the wheel hub does not have any free play.
7. Install retainer with slot aligned to cotter pin hole in spindle. Install cotter pin.
8. Fill dust cap approximately 50% full of grease. Install dust cap.
9. Install rear wheel (see Wheels in this section).
10. Lower machine to ground.
11. Torque lug nuts evenly in a crossing pattern from **70 to 90 ft-lb (95 to 122 N-m)**.

Rear Axle

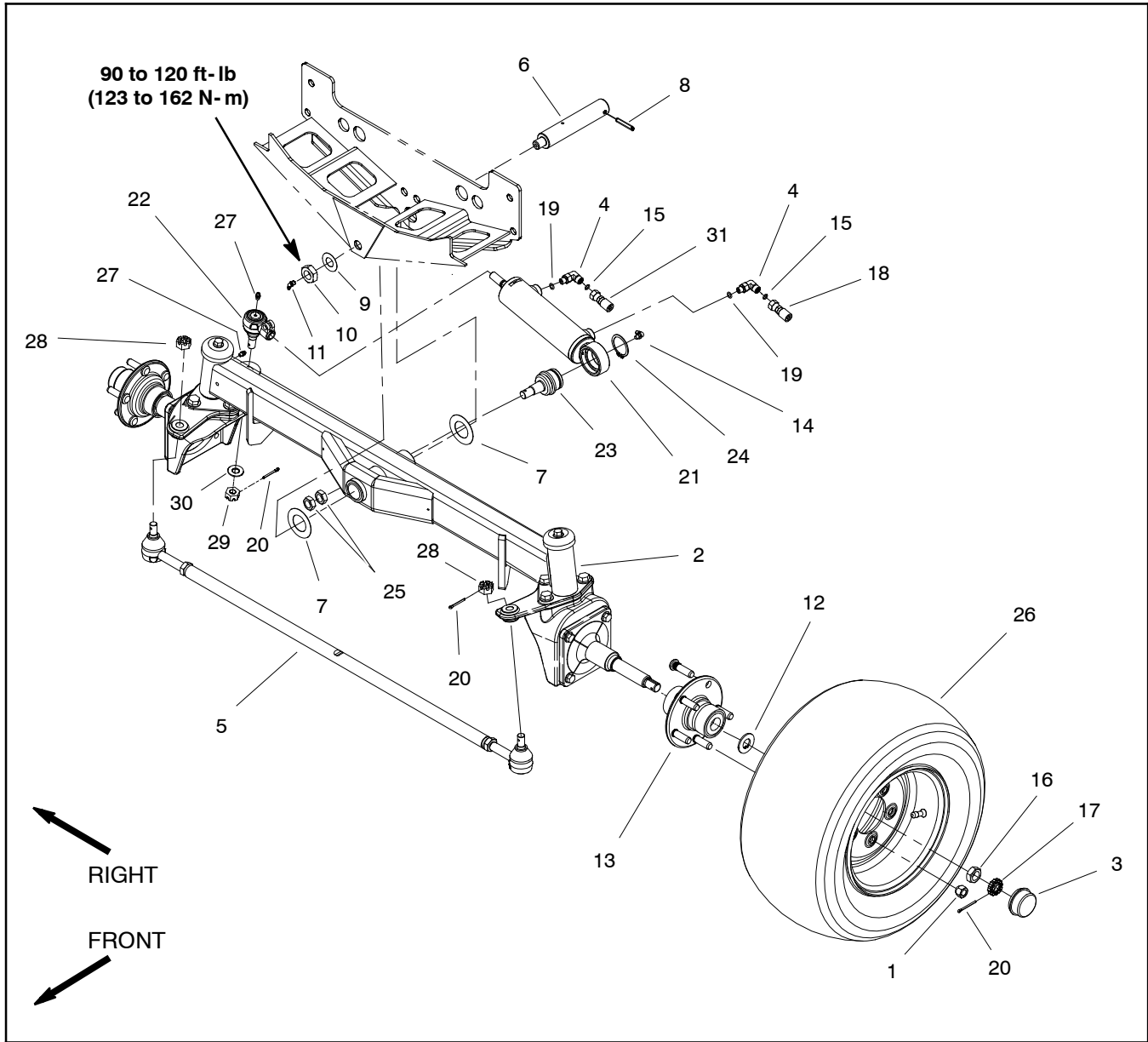


Figure 11

- 1. Lug nut (5 used per wheel)
- 2. Rear axle assembly
- 3. Dust cap
- 4. Hydraulic fitting
- 5. Tie rod
- 6. Axle pivot pin
- 7. Thrust washer
- 8. Roll pin
- 9. Thrust washer
- 10. Jam nut
- 11. Grease fitting

- 12. Tab washer
- 13. Wheel hub assembly
- 14. Grease fitting
- 15. O-ring
- 16. Jam nut
- 17. Nut retainer
- 18. Hydraulic hose
- 19. O-ring
- 20. Cotter pin
- 21. Steering cylinder

- 22. Ball joint
- 23. Ball joint
- 24. Retaining ring
- 25. Jam nut
- 26. Wheel assembly
- 27. Grease fitting
- 28. Slotted hex nut
- 29. Slotted hex nut
- 30. Washer
- 31. Hydraulic hose

Removal (Fig. 11)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.
2. Chock front wheels to prevent machine from shifting.
3. Thoroughly clean hydraulic hose ends and fittings on steering cylinder to prevent hydraulic system contamination.

NOTE: To ease assembly, label hydraulic hoses to show their correct position on the steering cylinder.

4. Disconnect the hydraulic hoses from the steering cylinder. Put caps or plugs on all fittings and hoses to prevent contamination.
5. Remove the jam nut (item 10) and thrust washer (item 9) that secure the axle pivot pin (item 6) to the frame.
6. Jack up the machine (just ahead of the rear wheels) until clearance exists to allow rear axle removal. Support the machine with jack stands or appropriate load holding device to prevent it from falling.
7. Support rear axle to prevent it from falling.
8. Pull the axle pivot pin from frame and rear axle. This will release the rear axle and thrust washers (item 7) from the frame. Carefully pull the entire axle and wheel assembly out from under the machine.

Installation (Fig. 11)

1. Thoroughly clean the rear axle pivot pin. Inspect the pin for wear or damage and replace if necessary.
2. Position the rear axle assembly to the frame. Install thrust washer (item 7) between each side of axle and frame. Raise axle assembly to frame and slide pivot pin through frame, thrust washers and axle. Make sure that roll pin on pivot pin is positioned in frame reliefs.
3. Install thrust washer (item 9) and jam nut (item 10) onto pivot pin. Torque jam nut (item 10) from **90 to 120 ft-lb (123 to 162 N-m)**. Make sure that axle can still pivot freely after jam nut is tightened.
4. Lower the machine to the ground.
5. Correctly install the hydraulic hoses to the steering cylinder.
6. Check oil level in hydraulic reservoir.
7. Lubricate the rear axle pivot bushings through the grease fitting on the axle pivot pin.
8. Operate machine and check steering cylinder hydraulic connections for leaks.

Rear Axle Service

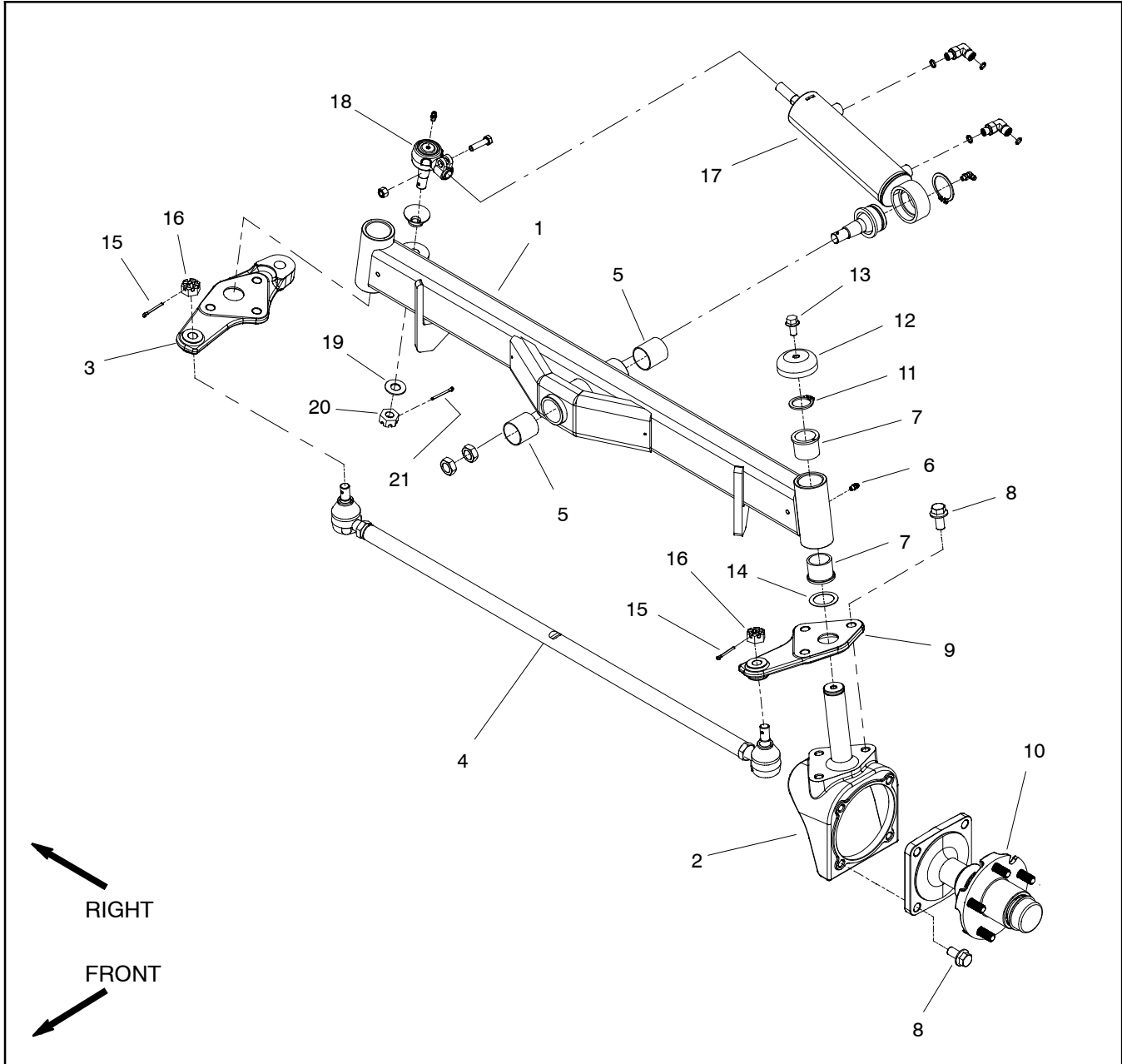


Figure 12

- | | | |
|----------------------------|--|-----------------------|
| 1. Rear axle | 8. Flange head screw (7 used per side) | 15. Cotter pin |
| 2. Housing (2 used) | 9. LH drag link | 16. Slotted hex nut |
| 3. RH drag link | 10. Hub and spindle assembly (2 used) | 17. Steering cylinder |
| 4. Tie rod assembly | 11. Retaining ring | 18. Ball joint |
| 5. Pivot bushing (2 used) | 12. Spindle cap | 19. Washer |
| 6. Grease fitting (2 used) | 13. Flange head screw | 20. Slotted hex nut |
| 7. Flange bushing (4 used) | 14. Thrust washer | 21. Cotter pin |

Axle Pivot Bushings (Fig. 12)

The rear axle must be held in place snugly by the axle pivot pin. Excessive movement of the axle, which is characterized by erratic steering, might indicate worn axle pivot bushings (item 5). To correct the problem, replace the bushings.

1. Remove rear axle from machine (see Rear Axle in this section).
2. Use a bushing removal tool to extract both axle pivot bushings from the rear axle pivot tube. Take care to not damage bore of pivot tube during bushing removal. Clean the inside of the tube to remove all dirt and foreign material.
3. Apply grease to the inside and outside of the new bushings. Use an arbor press to install the bushings into the front and back of the rear axle pivot tube. Bushings must be flush with the axle tube after installation.
4. Install rear axle to machine (see Rear Axle in this section).

Rear Axle Housing Bushings (Fig. 12)

The rear axle housing shafts (item 2) must fit snugly in the rear axle. Excessive movement of the housing shaft in the axle might indicate that the flange bushings (item 7) are worn and must be replaced.

1. Remove rear axle from machine (see Rear Axle in this section).
2. Remove cotter pin and slotted hex nut that secure the tie rod end to the drag link. Separate the tie rod end from the drag link.
3. If right side housing is being removed from axle, remove cotter pin, washer and slotted hex nut that secure steering cylinder ball joint (item 18) to RH drag link. Separate steering cylinder from drag link.
4. Remove the flange head screw (item 12), spindle cap (item 13) and retaining ring (item 11) that secure the housing shaft into the rear axle tube. Slide the housing and wheel assembly out of the axle tube to expose the flange bushings. Locate and retrieve thrust washer (item 14) from housing shaft.

5. Use a bushing removal tool to extract both flange bushings (item 7) from the axle tube. Take care to not damage the bore of the axle tube. Clean the inside of the axle tube to remove all dirt or foreign material.

6. Apply grease to the inside and outside of the new flange bushings. Use an arbor press to install the bushings into the top and bottom of the axle tube. Press bushings into tube until flange shoulder bottoms on tube.

7. Thoroughly clean the housing shaft. Inspect the shaft for wear and replace if worn or damaged.

8. Install thrust washer (item 14) onto the housing shaft and slide the shaft up through the rear axle tube. Hold the housing shaft and wheel assembly in place and install the retaining ring (item 11) onto the housing shaft. Make sure that retaining ring is fully seated into housing shaft groove after installation.

9. Install the spindle cap (item 13) and flange head screw (item 12).

10. Connect the tie rod end to the drag link with slotted hex nut and cotter pin.

11. If separated, secure steering cylinder ball joint to RH drag link with slotted hex nut, washer and cotter pin.

12. Install rear axle to machine (see Rear Axle in this section).

13. Lubricate the steering spindles through the grease fittings on the rear axle.

14. Check rear wheel toe-in (see Traction Unit Operator's Manual).

15. After all adjustments have been made, make sure that no contact is made between any machine components as the wheels are moved from lock to lock. Adjust if necessary.

Control Arm

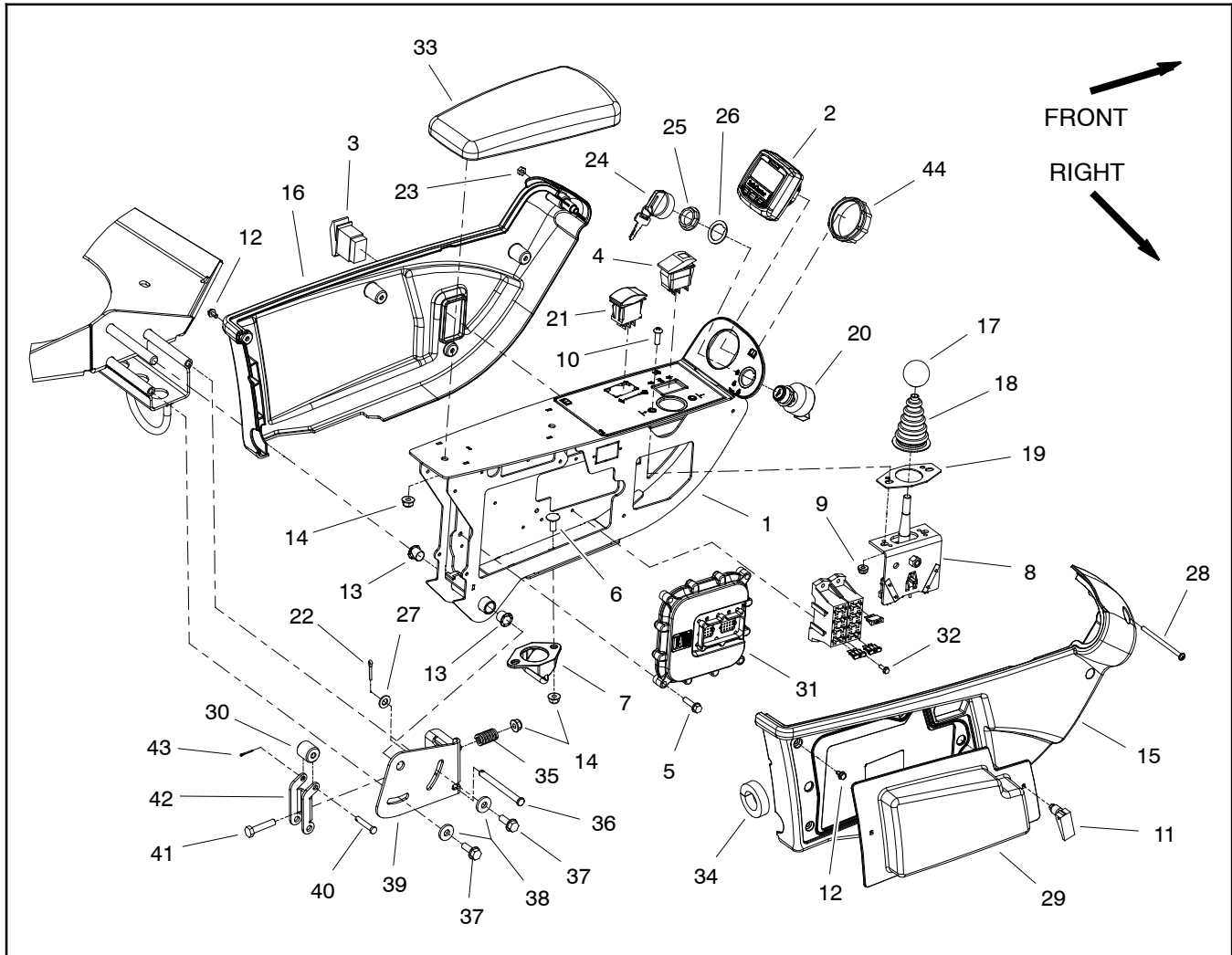


Figure 13

- | | | |
|---------------------------------|--------------------------|--------------------------------|
| 1. Control arm frame | 16. LH control arm cover | 31. TEC controller |
| 2. InfoCenter display | 17. Knob | 32. Washer head screw (4 used) |
| 3. Headlight switch | 18. Boot | 33. Arm rest |
| 4. Reel engage/disengage switch | 19. Boot plate | 34. Foam seal |
| 5. Screw (4 used) | 20. Ignition switch | 35. Compression spring |
| 6. Carriage screw (2 used) | 21. Engine speed switch | 36. Clevis pin |
| 7. Latch | 22. Cotter pin | 37. Screw (2 used) |
| 8. Joystick assembly | 23. Lock nut | 38. Flat washer (2 used) |
| 9. Flange nut (2 used) | 24. Key set | 39. Retainer bracket |
| 10. Screw (2 used) | 25. Mounting nut | 40. Clevis pin |
| 11. Swell latch (2 used) | 26. Backup washer | 41. Cap screw |
| 12. Washer head screw (10 used) | 27. Flat washer | 42. Latch |
| 13. Bushing (2 used) | 28. Screw | 43. Cotter pin |
| 14. Flange nut (5 used) | 29. Access cover | 44. Nut |
| 15. RH control arm cover | 30. Spacer | |

Disassembly (Fig. 13)

1. Park machine on a level surface, lower cutting units, stop engine and engage parking brake. Remove key from ignition switch.
2. Loosen latches and remove access cover from outside of control arm.
3. At front of control arm, remove screw (item 28) and lock nut (item 23) that secure control arm covers to each other.
4. Remove five (5) washer head screws (item 12) that secure each cover to control arm.
5. Remove control arm covers from machine. As LH control arm cover (item 16) is removed from control arm, unplug wire harness connector from headlight switch.
6. Remove electrical components from control arm as needed using Figure 13 as a guide.

Assembly (Fig. 13)

1. Install all removed electrical components to control arm using Figure 13 as a guide.
2. Position covers to control arm. As LH cover (item 16) is placed, plug wire harness connector to headlight switch. Also, make sure that wire harness is routed correctly through cover openings (shown in Fig. 14).
3. Secure each cover to control arm with five (5) washer head screws (item 12). Install screw (item 28) and lock nut (item 23) to secure covers at front of control arm.
4. Install access cover to outside of control arm.

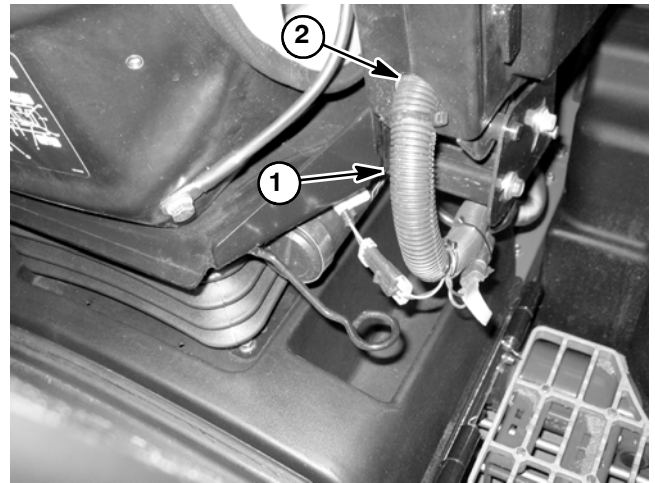


Figure 14

1. Wire harness

2. Harness foam seal

Operator Seat

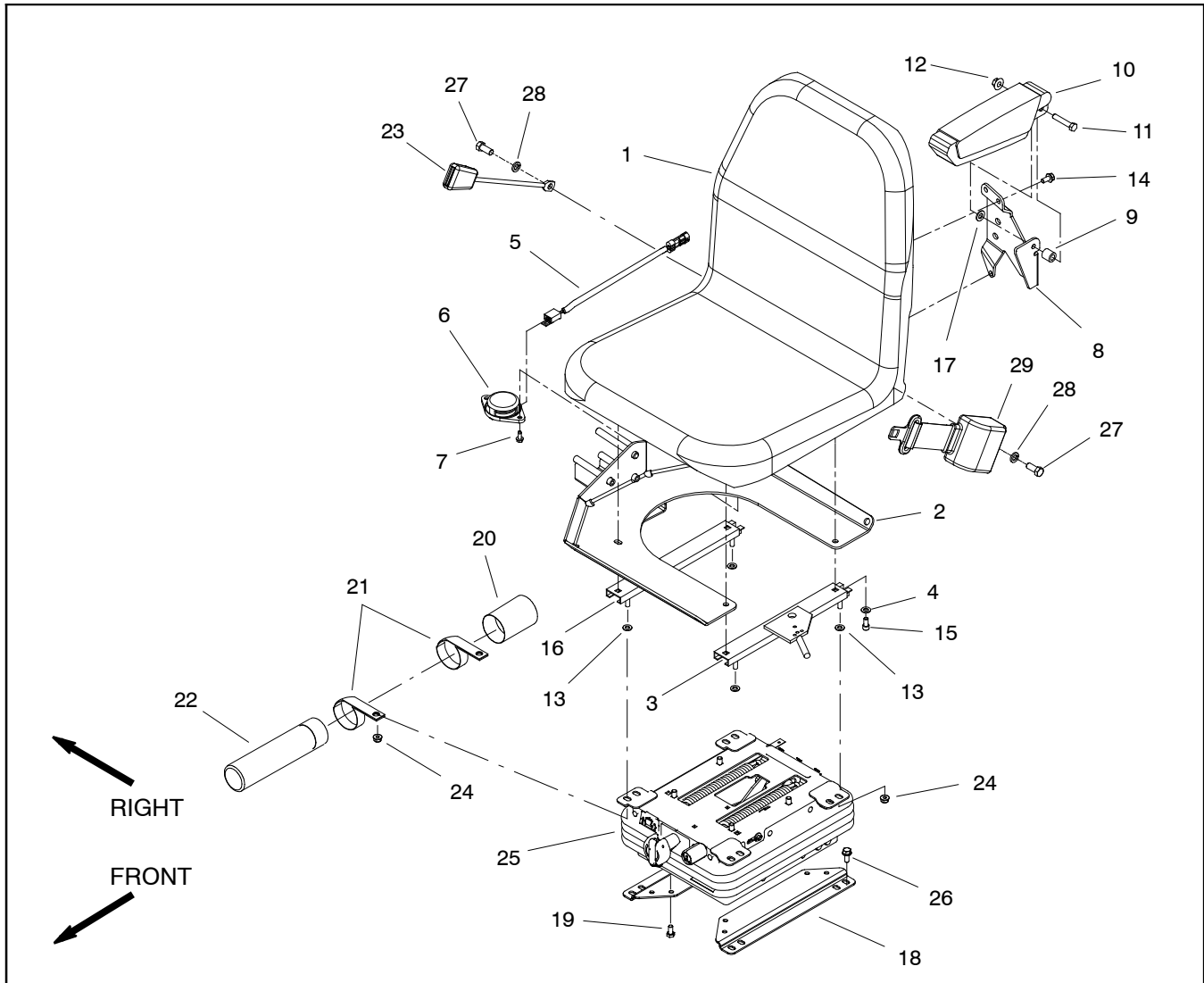


Figure 15

- | | | |
|-------------------------------|--------------------------------|--------------------------------|
| 1. Operator seat | 11. Cap screw | 21. R-clamp (2 used) |
| 2. Seat base | 12. Flange nut | 22. Manual housing |
| 3. Seat adjuster w/latch | 13. Flat washer (4 used) | 23. Seat belt buckle |
| 4. Flat washer (4 used) | 14. Flange head screw (3 used) | 24. Flange nut (4 used) |
| 5. Seat switch harness | 15. Socket head screw (4 used) | 25. Seat suspension |
| 6. Seat switch | 16. Seat adjuster | 26. Flange head screw (4 used) |
| 7. Washer head screw (2 used) | 17. Flat washer | 27. Cap screw (2 used) |
| 8. Armrest bracket | 18. Seat bracket (2 used) | 28. Lock washer (2 used) |
| 9. Spacer | 19. Cap screw (4 used) | 29. Seat belt |
| 10. Armrest | | |

IMPORTANT: The operator seat, seat base and control arm assembly are attached to the machine with the same fasteners. Make sure to support the seat base and control arm to prevent them from shifting when removing the seat. Damage to control arm electrical components and control arm wiring harness can occur if the seat base and control arm are not properly supported during seat removal.

Removal (Fig. 15)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.
2. Disconnect negative battery cable from 12 volt battery at rear of machine (see 12 Volt Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).
3. Disconnect seat switch electrical connector from wire harness (Fig. 16).
4. Remove two (2) flange head screws and flat washers that secure retainer bracket assembly and control arm assembly to seat base (Fig. 17). Remove retainer bracket assembly.

IMPORTANT: Take care to not damage the electrical wire harness when removing seat and control arm assembly from machine.

5. Carefully slide control arm assembly from seat base. Make sure that two (2) bushings remain in pivot of control arm assembly. Position and support control arm assembly to allow seat removal.
6. Remove four (4) socket head screws (item 15) and flat washers (item 4) that secure seat and seat base to seat adjusters. Note location of fasteners for assembly purposes.
7. Support seat base to keep it positioned on seat adjusters.
8. Remove operator seat from seat base and seat adjusters. Note location of fasteners for assembly purposes.

Installation (Fig. 15)

1. Position seat and seat base to seat adjusters. Use forward set of mounting holes in bottom of seat when aligning seat with seat base and adjusters.
2. Secure seat and seat base to seat adjusters with four (4) flat washers (item 4) and socket head screws (item 15).

IMPORTANT: Take care to not damage electrical wire harness when installing control arm assembly to machine.

3. Make sure that two (2) bushings are positioned in control arm pivot area. Carefully slide control arm assembly onto seat base post.

4. Position retainer bracket assembly to control arm and secure with two (2) flange head screws and flat washers (Fig. 17).
5. Connect seat switch electrical connector to wire harness.
6. Connect negative battery cable to 12 volt battery at rear of machine (see 12 Volt Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).

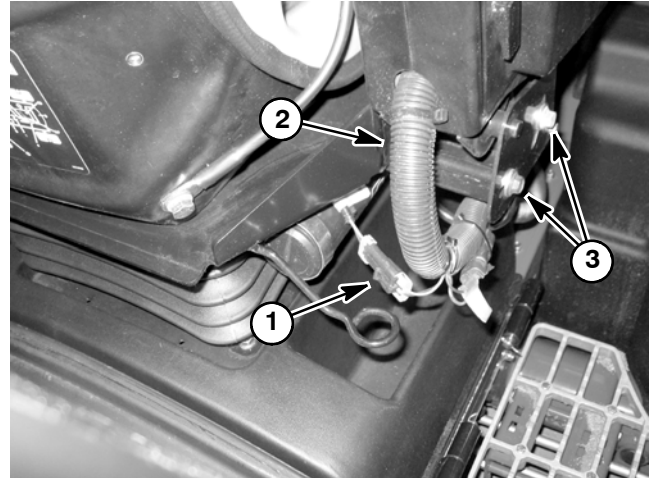


Figure 16

- | | |
|---------------------|-----------------|
| 1. Seat switch lead | 3. Flange screw |
| 2. Wire harness | |

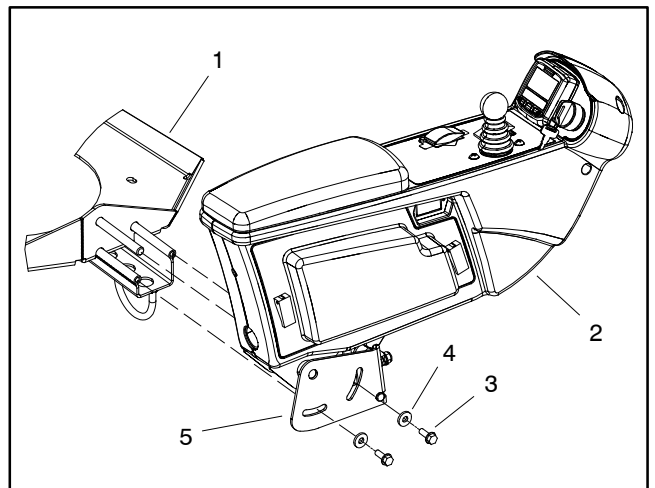


Figure 17

- | | |
|--------------------------|--------------------------|
| 1. Seat base | 4. Flat washer (2 used) |
| 2. Control arm assembly | 5. Retainer bracket assy |
| 3. Flange screw (2 used) | |

Mechanical Seat Suspension

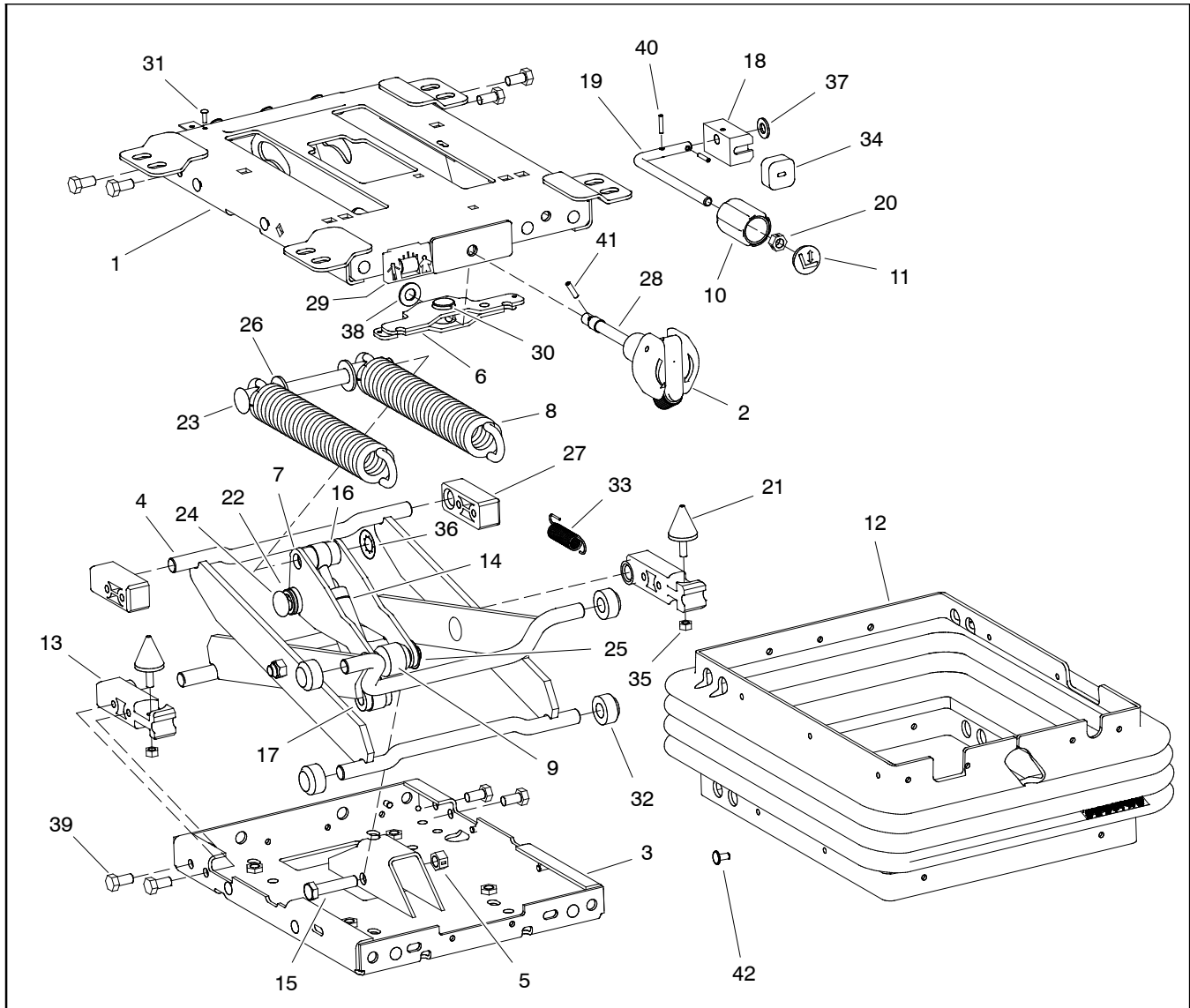


Figure 18

- | | | |
|------------------------------|----------------------------------|-----------------------------------|
| 1. Upper housing | 15. Lower shock bolt | 29. Weight indicator assembly |
| 2. Weight adjust knob | 16. Upper shock bushing (2 used) | 30. Weight adjust nut |
| 3. Lower housing | 17. Lower shock bushing (2 used) | 31. Rivet |
| 4. Scissor assembly | 18. Stop bumper | 32. Roller (4 used) |
| 5. Lock nut | 19. Height adjust rod | 33. Extension spring |
| 6. Weight adjuster | 20. Lock nut | 34. Bumper |
| 7. Drive arm | 21. Stop bumper (2 used) | 35. Hex nut (2 used) |
| 8. Extension spring (2 used) | 22. Bearing tube (2 used) | 36. Retainer (3 used) |
| 9. Roller guide | 23. Spring shaft | 37. Flat washer |
| 10. Weight adjust knob | 24. Pivot pin | 38. Flat washer |
| 11. Cap | 25. Roller pin | 39. Thread forming screw (8 used) |
| 12. Suspension boot | 26. Spring bushing (2 used) | 40. Roll pin (2 used) |
| 13. Pivot block (2 used) | 27. Shaft block (2 used) | 41. Roll pin |
| 14. Damper | 28. Weight adjust spacer | 42. Clip (20 used) |

IMPORTANT: When removing the seat suspension, make sure to support the control arm to prevent damage to the control arm electrical components and control arm wiring harness.

Removal (Figs. 18 and 19)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.
2. Disconnect negative battery cable from 12 VDC battery (see 12 Volt Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).
3. Remove seat from machine (see Operator Seat in this section).

IMPORTANT: Take care to not damage the electrical harness when removing seat suspension from machine.

4. Tilt and support seat frame to allow access to seat suspension fasteners.
5. Support seat suspension to prevent it from falling. Remove four (4) flange head screws (item 8 in Figure 19) and flange nuts (item 5 in Figure 19) that secure seat suspension with attached seat brackets to seat base.
6. Remove seat suspension assembly from machine. Locate and retrieve four (4) spacers (item 7 in Figure 19) from between seat suspension assembly and seat base.
7. Remove seat suspension components as needed using Figures 18 and 19 as guides.

Installation (Figs. 18 and 19)

1. Install all removed seat suspension components using Figures 18 and 19 as guides.

A. If seat adjusters (items 12 or 13 in Figure 19) were removed from seat suspension, install adjuster studs in rear set of holes in the suspension. Also, make sure that washer (item 9 in Figure 19) is placed between seat adjuster and suspension.

IMPORTANT: Take care to not damage the electrical harness when installing seat suspension to machine.

2. Position seatbase cover and four (4) spacers (item 7 in Figure 19) to seat base.
3. Position seat suspension with attached seat brackets to seat base. Use rear set of mounting holes in seat brackets when aligning seat suspension assembly with seat base. Secure with four (4) flange head screws (item 8 in Figure 19) and flange nuts (item 5 in Figure 19).
4. Install seat to machine (see Operator Seat in this section). Make sure to connect wire harness electrical connector to the seat switch.
5. Connect negative battery cable to 12 VDC battery (see 12 Volt Battery Service in the Service and Repairs section of Chapter 5 - Electrical System).

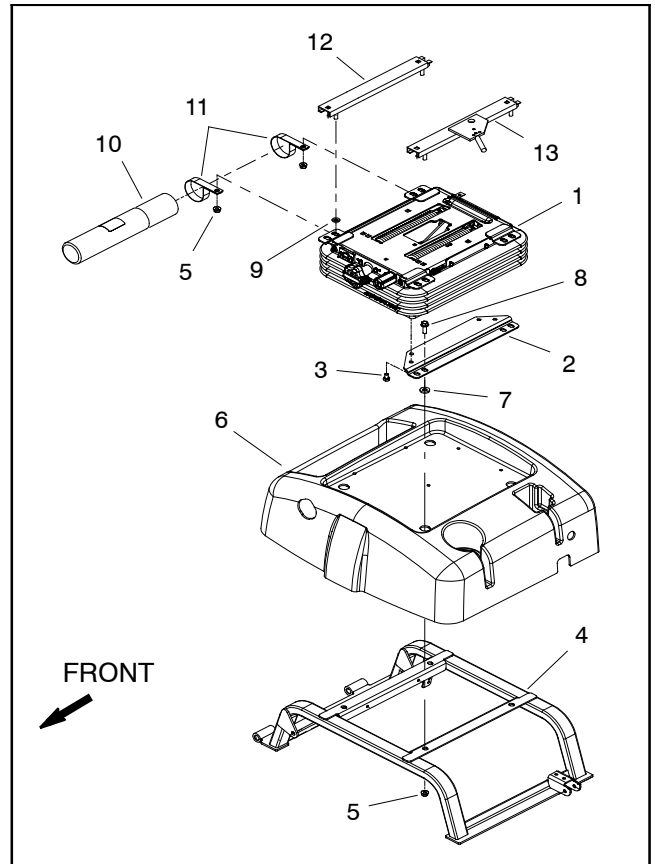


Figure 19

- | | |
|--------------------------|---------------------------|
| 1. Seat suspension | 8. Flange screw (4 used) |
| 2. Seat bracket (2 used) | 9. Flat washer (4 used) |
| 3. Screw (4 used) | 10. Manual tube |
| 4. Seat base | 11. R-clamp (2 used) |
| 5. Flange nut (8 used) | 12. Seat adjuster |
| 6. Seatbase cover | 13. Seat adjuster w/latch |
| 7. Spacer (4 used) | |

Front Lift Arms

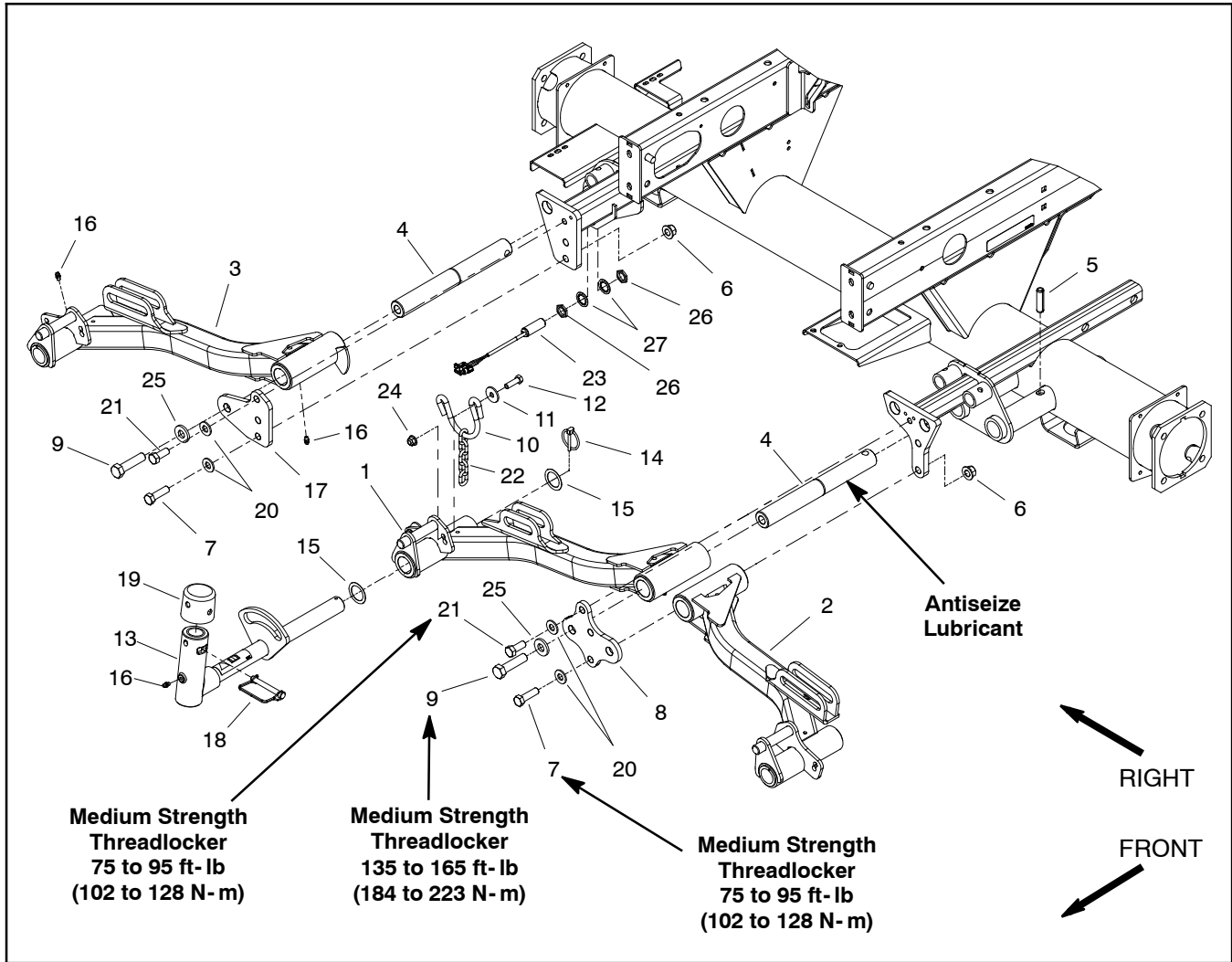


Figure 20

- | | | |
|------------------------------------|---------------------------------------|--|
| 1. #1 lift arm | 10. Chain hoop (3 used) | 19. Cap (1 used per lift arm) |
| 2. #4 lift arm | 11. Washer (2 used per chain hoop) | 20. Thrust washer (6 used) |
| 3. #5 lift arm | 12. Cap screw (2 used per chain hoop) | 21. Cap screw (2 used) |
| 4. Lift arm pivot shaft (3 used) | 13. Pivot yoke (3 used) | 22. Chain (3 used) |
| 5. Roll pin (3 used) | 14. Lynch pin (3 used) | 23. Up limit switch |
| 6. Lock nut (4 used) | 15. Thrust washer (2 used per yoke) | 24. Flange nut (2 used per chain hoop) |
| 7. Cap screw (4 used) | 16. Grease fitting | 25. Flat washer (1 used per lift arm) |
| 8. Bridge plate | 17. Bridge plate | 26. Jam nut (2 used) |
| 9. Cap screw (1 used per lift arm) | 18. Snapper pin (1 used per lift arm) | 27. Lock washer (2 used) |

Removal (Fig. 20)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove cutting unit from front lift arm to be removed.
3. Remove one retaining ring (item 3 in Fig. 21) and thrust washer (item 4 in Fig. 21) from the cylinder slide pin (item 5 in Fig. 21) that secures lift cylinder to lift arm. Pull slide pin from the lift cylinder and lift arm. Locate and retrieve second thrust washer.

4. Pivot lift cylinder rod end away from lift arm.
5. Remove lynch pin (item 14) and slide pivot yoke assembly from lift arm. Locate and retrieve two (2) thrust washers (item 15).
6. Remove fasteners that secure bridge plate (item 8 or 17) to machine.
7. Slide front lift arm from lift arm pivot shaft.

8. Inspect bushings in lift arm and pivot yoke for wear or damage. If necessary, replace bushings (Figs. 22 and 23).

A. Use bushing removal tool to extract bushings from the lift arm or pivot yoke. Take care to not damage the bore.

B. Clean the inside of the bore to remove any dirt or foreign material.

C. Apply grease to the inside and outside of the new bushings.

D. Use an arbor press to install the bushings into lift arm or pivot yoke. Lift arm bushings should be pressed until bushing flange is against lift arm bore. The upper pivot yoke bushing should be pressed fully to the shoulder in the pivot yoke bore. The lower pivot yoke bushing should be flush with the yoke tube.

9. Check lift arm pivot shaft (item 4) for wear or damage. If necessary, remove roll pin (item 5) that secures pivot shaft to frame and remove pivot shaft. Discard removed roll pin.

Installation (Fig. 20)

1. If lift arm pivot shaft (item 4) was removed from frame, apply antiseize lubricant to portion of pivot shaft that is in frame bore. Slide pivot shaft into frame and secure with new roll pin (item 5).

2. Slide front lift arm onto pivot shaft.

3. Apply medium strength threadlocker to threads of cap screws (items 7, 9 and 21) that secure bridge plate (items 8 and 17). Secure lift arm to machine with bridge plate. Torque cap screws that secure bridge plate to torque values identified in Figure 20.

4. Position thrust washer (item 15) onto pivot yoke shaft and then slide pivot yoke into lift arm bushings. Place second thrust washer on pivot yoke shaft and secure with lynch pin (item 14).

5. Align lift cylinder to lift arm mounting slot (Fig. 21). Slide cylinder slide pin (item 5 in Fig. 21) with retaining ring (item 3 in Fig. 21) and thrust washer (item 4 in Fig. 21) through the lift arm and lift cylinder. Install second thrust washer on pin and secure with second retaining ring.

6. Mount cutting unit to lift arm.

7. Lubricate grease fittings on lift arm, pivot yoke and lift cylinder.

8. Check operation of lift arm up limit switch and adjust if necessary (see Up Limit Switch in Components section of Chapter 6 - Electrical System).

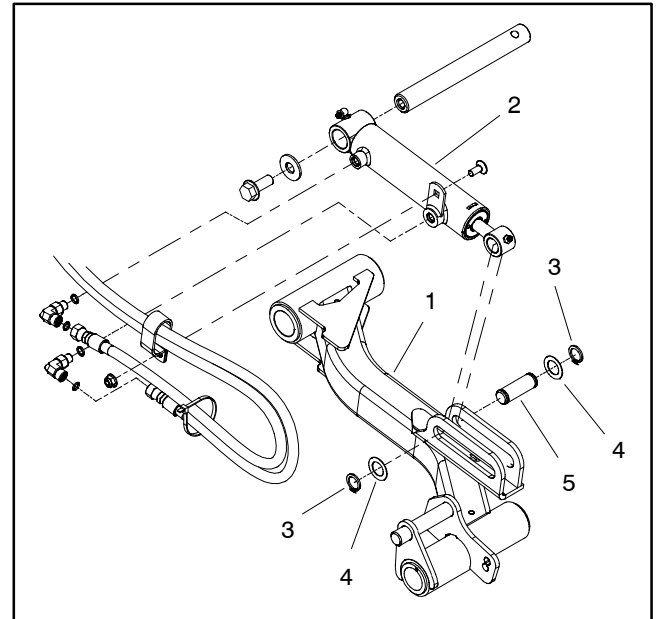


Figure 21

- | | |
|------------------------|-----------------------|
| 1. Lift arm (#4 shown) | 4. Thrust washer |
| 2. Lift cylinder | 5. Cylinder slide pin |
| 3. Retaining ring | |

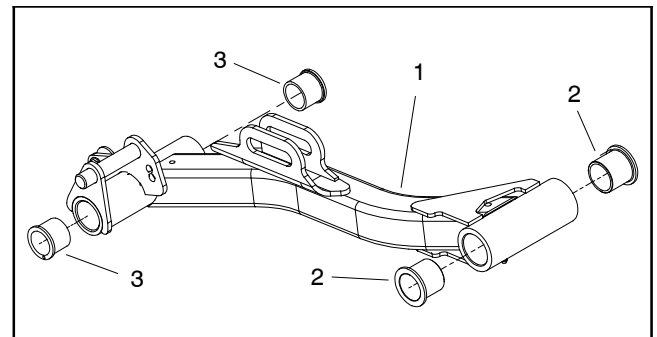


Figure 22

- | | |
|------------------------|-----------------------|
| 1. Lift arm (#5 shown) | 3. Pivot yoke bushing |
| 2. Lift arm bushing | |

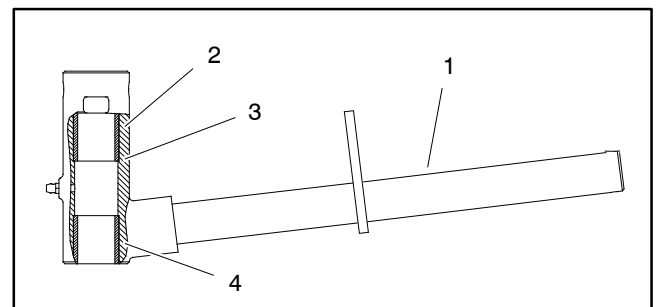


Figure 23

- | | |
|------------------|------------------------|
| 1. Pivot yoke | 3. Pivot yoke shoulder |
| 2. Upper bushing | 4. Lower bushing |

Rear Lift Arms

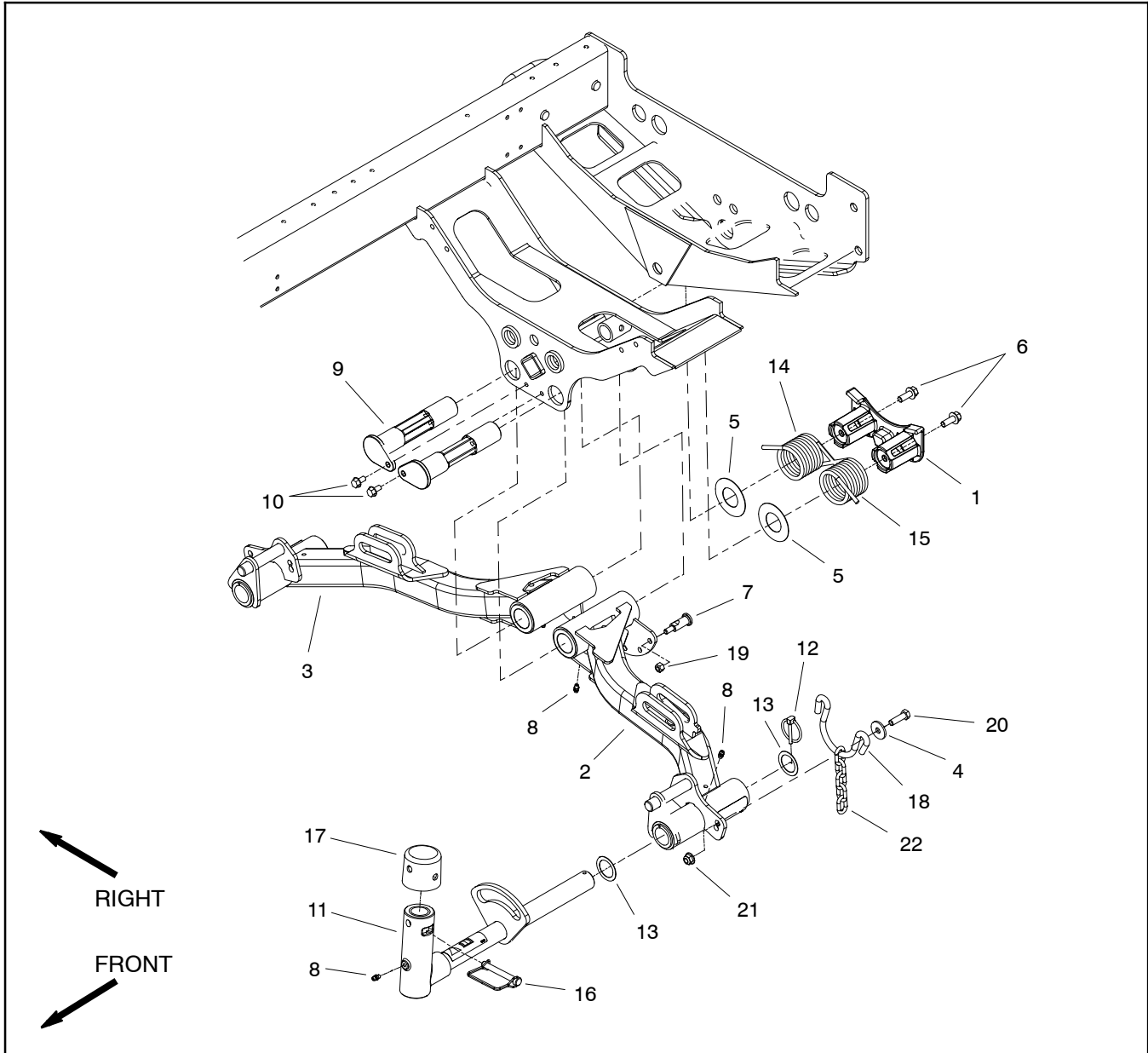


Figure 24

- | | | |
|-----------------------------------|--|--|
| 1. Housing | 9. Pivot shaft (2 used) | 16. Snapper pin (1 used per yoke) |
| 2. #2 lift arm | 10. Washer head screw (1 used per shaft) | 17. Cap (1 used per yoke) |
| 3. #3 lift arm | 11. Pivot yoke (2 used) | 18. Chain hoop (2 used) |
| 4. Washer (2 used per chain hoop) | 12. Lynch pin (2 used) | 19. Lock nut (6 used) |
| 5. Washer (2 used) | 13. Thrust washer (2 used per yoke) | 20. Cap screw (2 used per chain hoop) |
| 6. Flange head screw (2 used) | 14. RH torsion spring | 21. Flange nut (2 used per chain hoop) |
| 7. Shoulder stud (6 used) | 15. LH torsion spring | 22. Chain (2 used) |
| 8. Grease fitting | | |

Removal (Fig. 24)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove cutting unit from rear lift arm that is to be removed.

3. Remove one retaining ring (item 3 in Fig. 25) and thrust washer (item 4 in Fig. 25) from the cylinder pin (item 5 in Fig. 25) that secures lift cylinder to lift arm. Pull cylinder pin from the lift cylinder and lift arm. Locate and retrieve second thrust washer.

4. Pivot lift cylinder rod end away from lift arm.

5. Remove lynch pin (item 12) and rear thrust washer (item 13) from rear of pivot yoke. Slide pivot yoke assembly from lift arm. Locate and retrieve front thrust washer (item 13).



CAUTION

Be careful when removing tension from the torsion spring on the rear lift arms. The spring is under heavy load and may cause personal injury.

6. Remove tension from both torsion springs (items 14 and 15) on rear of lift arm pivot shaft.

A. Note on which shoulder stud (item 7) the torsion spring end is attached for assembly purposes.

B. Insert nut driver or small piece of pipe onto the end of the torsion spring that is secured to the shoulder stud.

C. Push down and rearward on the spring end to unhook the spring from the shouldered stud (item 7).

7. Remove two (2) flange head screws (item 6) that secure housing (item 1) to machine. Remove housing, torsion springs (items 14 and 15) and two (2) washers (item 5).

8. Remove washer head screw (item 10) that secures pivot shaft (item 9) to frame.

9. Support rear lift arm to prevent it from falling. Slide pivot shaft from frame and lift arm. Remove rear lift arm.

10. Inspect pivot shaft and replace if worn or damaged.

11. Inspect bushings in lift arm and pivot yoke for wear or damage. If necessary, replace bushings (Figs. 26 and 27).

A. Use bushing removal tool to extract both bushings from the lift arm or pivot yoke. Take care to not damage the bore.

B. Clean the inside of the bore to remove any dirt or foreign material.

C. Apply grease to the inside and outside of the new bushings.

D. Use an arbor press to install the bushings into lift arm or pivot yoke. Lift arm bushings should be pressed until bushing flange is against lift arm bore. The upper pivot yoke bushing should be pressed fully to the shoulder in the pivot yoke bore. The lower pivot yoke bushing should be flush with the yoke tube.

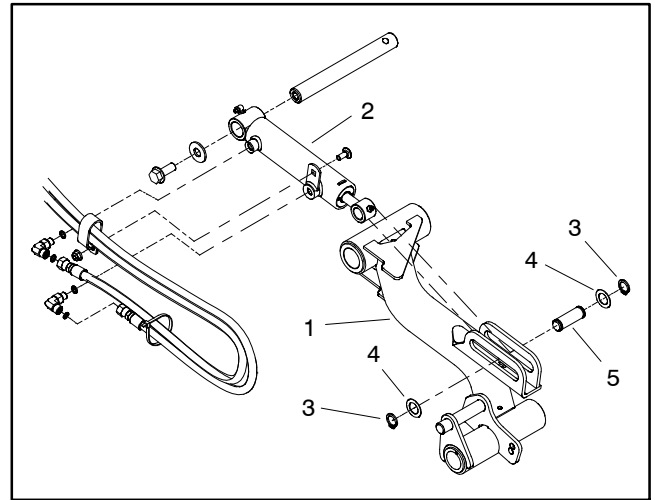


Figure 25

- | | |
|------------------------|------------------|
| 1. Lift arm (#2 shown) | 4. Thrust washer |
| 2. Lift cylinder | 5. Cylinder pin |
| 3. Retaining ring | |

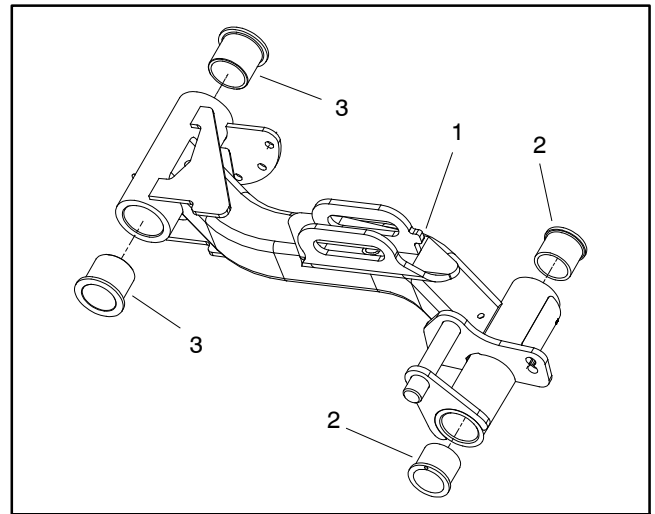


Figure 26

- | | |
|-----------------------------|---------------------|
| 1. Rear lift arm (#2 shown) | 3. Lift arm bushing |
| 2. Pivot yoke bushing | |

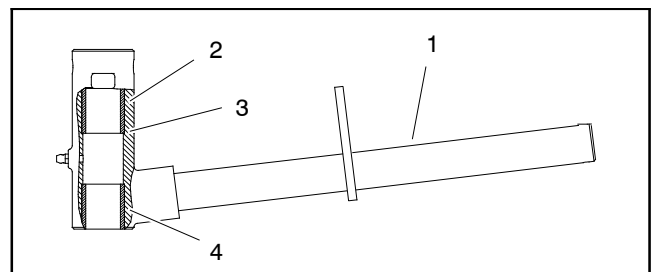


Figure 27

- | | |
|------------------|------------------------|
| 1. Pivot yoke | 3. Pivot yoke shoulder |
| 2. Upper bushing | 4. Lower bushing |

Chassis

Installation (Fig. 24)

1. Position rear lift arm to frame and slide pivot shaft through frame bosses and lift arm. Secure shaft with washer head screw (item 10).
2. Place washer (item 5) over rear of each pivot shaft.
3. Place torsions springs (items 14 and 15) onto housing (item 1). Position long leg of springs forward and pointing out from top of spring. Short leg of springs should be against stop on housing (Fig. 28).
4. Position housing (item 1) to lift arm pivot shafts and secure with two (2) flange head screws (item 6). Make sure that washers (item 5) remain on ends of pivot shafts and short end of torsion springs are against stop on housing.
5. Align lift cylinder rod end to lift arm mounting slot. Slide cylinder pin (item 5 in Fig. 25) with retaining ring (item 3 in Fig. 25) and thrust washer (item 4 in Fig. 25) through the lift cylinder and lift arm. Install second thrust washer on pin and secure with second retaining ring.

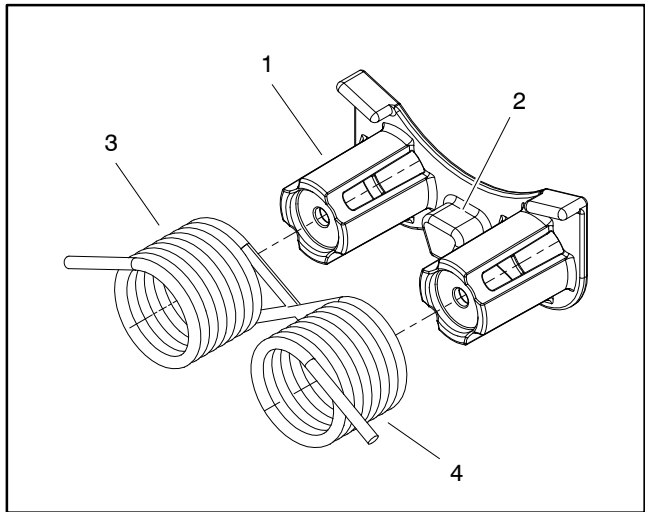


Figure 28

- | | |
|-----------------|----------------------|
| 1. Housing | 3. RH torsion spring |
| 2. Housing stop | 4. LH torsion spring |



CAUTION

Be careful when applying tension to the torsion spring on the rear lift arms. The spring is under heavy load and may cause personal injury.

6. Apply tension to torsion springs.
 - A. Insert nut driver or small piece of pipe onto the long leg of the torsion spring on the rear of the lift arm pivot pin.
 - B. Push down and forward on the spring end to hook the spring to the stop bolt on the lift arm.
7. Mount cutting unit to lift arm.
8. Lubricate grease fittings on lift arm, pivot yoke and lift cylinder.

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Hood

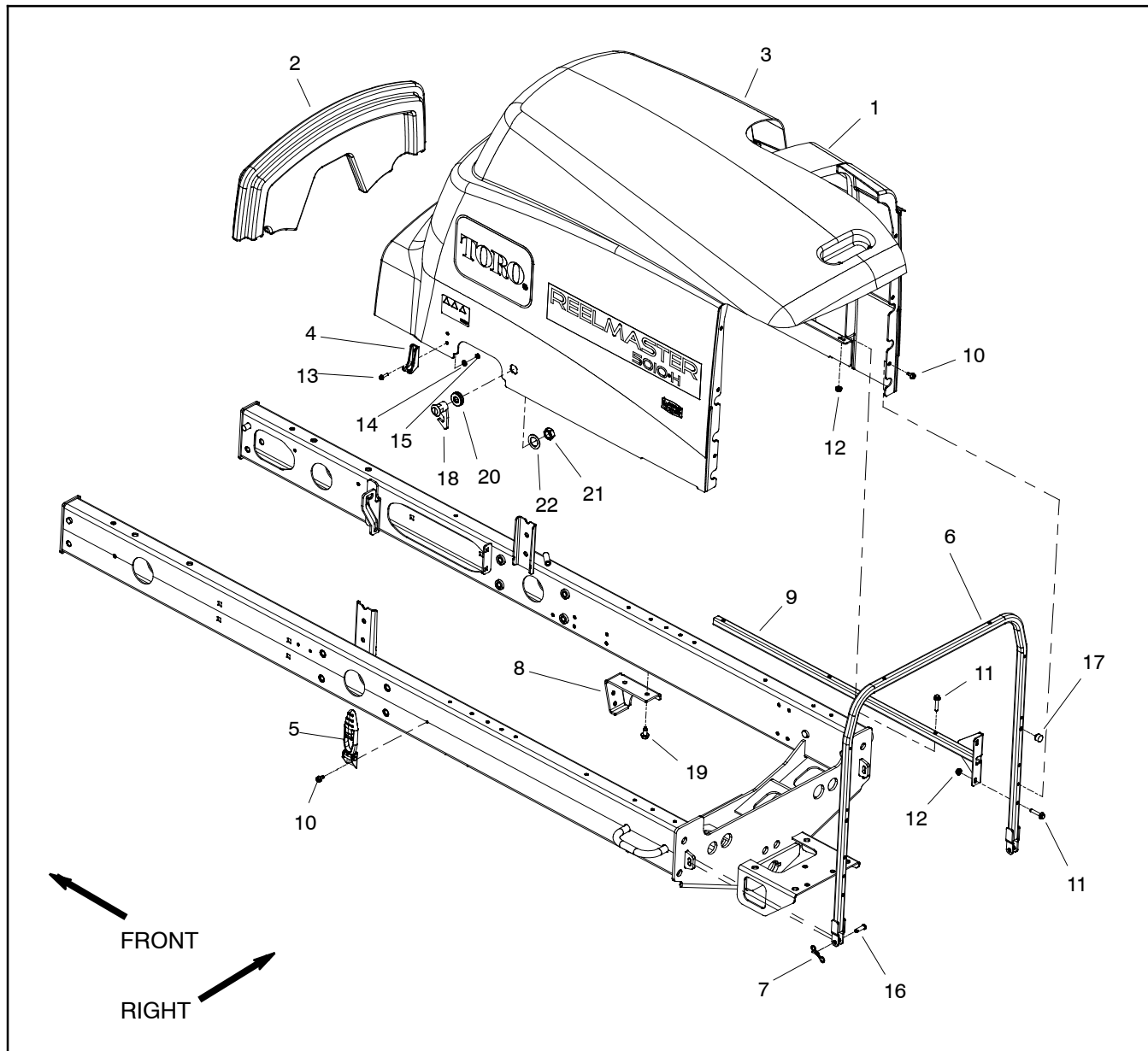


Figure 29

- | | | |
|-------------------------------|---------------------------------|--------------------------------|
| 1. Sealed foam | 9. Tube (2 used) | 16. Yoke pin (2 used) |
| 2. Hood saddle | 10. Washer head screw (8 used) | 17. Rubber bumper (2 used) |
| 3. Hood | 11. Flange head screw (10 used) | 18. Latch |
| 4. Catch (2 used) | 12. Flange nut (10 used) | 19. Washer head screw (4 used) |
| 5. Rubber latch (2 used) | 13. Washer head screw (4 used) | 20. Grommet |
| 6. Tube | 14. Flat washer (4 used) | 21. Hex nut |
| 7. Bow tie pin (2 used) | 15. Lock nut (4 used) | 22. Spacer |
| 8. Deflector bracket (2 used) | | |

Removal (Fig. 29)

1. Park the machine on a level surface, lower the cutting units and stop the engine. Remove the key from the ignition switch.
2. Unlatch hood.
3. Remove bow tie pin (item 7) and yoke pin (item 16) to allow hood removal.
4. Lift hood assembly from machine.
5. Remove hood components as necessary using Figure 29 as a guide.
6. Check condition of all seals on hood. Replace damaged or missing seals.

Installation (Fig. 29)

1. Install all removed hood components using Figure 29 as a guide.
2. Position hood assembly to machine and slide tube ends onto frame brackets.
3. Install yoke pin (item 16) and secure with bow tie pin (item 7).
4. Latch hood.

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Cutting Units

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Specifications

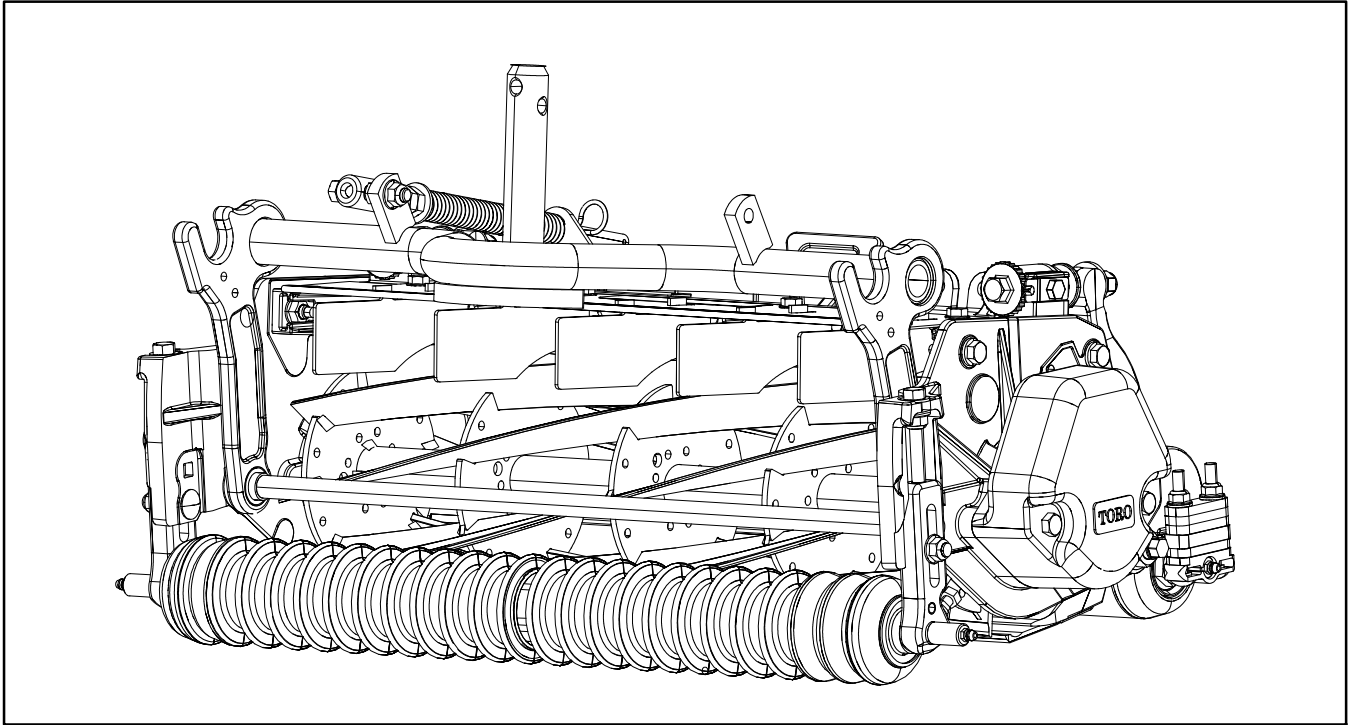


Figure 1

Frame Construction: Precision machined die cast aluminum cross member with two (2) bolt-on aluminum side plates.

Reel Construction: Reels are 22 inches (55.9 cm.) in length and are available in 5 inch (12.7 cm) and 7 inch (17.8 cm) diameters. High strength, low alloy steel blades are thru hardened and impact resistant. 5 inch and 7 inch reels are available in both 8 and 11 blade configurations.

Reel Bearings: Two (2) sealed, stainless steel ball bearings support the reel shaft with inboard spacer for protection.

Reel Drive: The reel weldment shaft is a 1 5/16 inch (33.3 mm) diameter tube with LH and RH drive inserts threaded into both ends. The drive inserts for 5 inch reels have an internal eight (8) tooth spline. The drive inserts for 7 inch reels have an internal nine (9) tooth spline.

Height-of-Cut (HOC): Cutting height is adjusted on the front roller by two (2) vertical screws. Effective HOC may vary depending on turf conditions, type of bedknife, roller type and installed attachments.

Bedknife: Replaceable, tool steel EdgeMax™ bedknife is fastened to a machined cast iron bedbar with eight (8) screws. Optional bedknives are available.

Bedknife Adjustment: Dual screw assemblies allow for precise bedknife adjustment. Adjustment detents correspond to bedknife movement for each indexed position as follows:

- 0.0007 inch (0.018 mm) for 5 inch reel
- 0.0009 inch (0.022 mm) for 7 inch reel

Front and Rear Rollers: Greaseable through-shaft front and rear rollers are used with these cutting units. All rollers use the same heavy duty, stainless steel ball bearings and seal package.

Cutting Unit Weight (without end weight):

8 Blade, 5 inch reel	90 lb. (41 kg)
11 Blade, 5 inch reel	93 lb. (42 kg)
8 Blade, 7 inch reel	118 lb. (54 kg)
11 Blade, 7 inch reel	121 lb. (55 kg)


Options: Refer to Cutting Unit Operator's Manual for available options for your Reelmaster cutting unit.

General Information

Cutting Unit Operator's Manual

The Cutting Unit Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for the cutting units on your Reelmaster machine. Additionally, if optional kits have been installed on the cutting units (e.g. groomer, rear roller brush), the installation instructions for the kit includes set-up and operation information. Refer to those publications for additional information when servicing the cutting units.

48 VDC Battery Disconnect

**CAUTION**

Before installing, removing or servicing components in the 48 VDC system (e.g. cutting unit motors, motor/generator), separate the 48 VDC battery disconnect. This will prevent unexpected operation of 48 VDC system components.

The 48 VDC battery disconnect is attached to the right frame rail under the operator seat (Fig. 2). Unplug the disconnect to make sure that 48 VDC components do not operate unexpectedly. Apply dielectric grease to the contact surfaces of the battery disconnect and plug the battery disconnect back in after service to the 48 VDC system is completed.

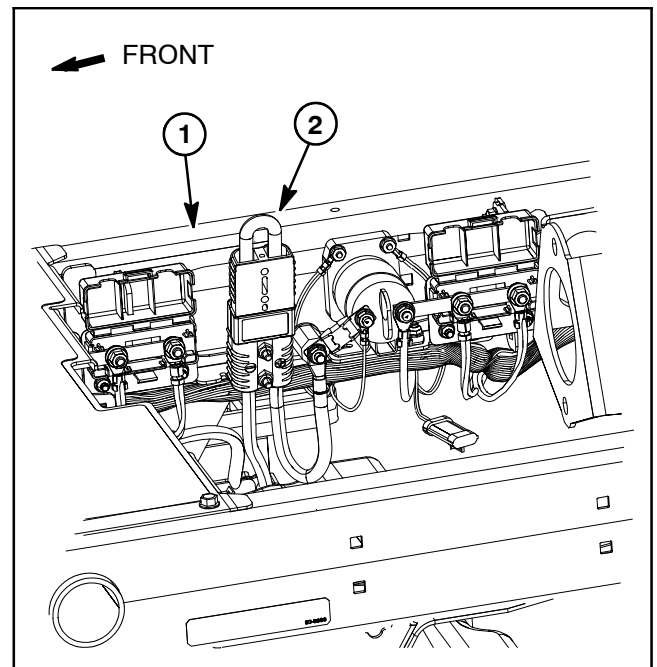


Figure 2

- 1. RH frame rail
- 2. 48V battery disconnect

Special Tools

Order special tools for your Reelmaster from your Toro Distributor. Some tools may have been supplied with your machine or are available as Toro parts.

Gauge Bar Assembly

Toro Part Number: **108-6715**

Use gauge bar to verify height-of-cut adjustment. Also used for adjustment of optional groomer.

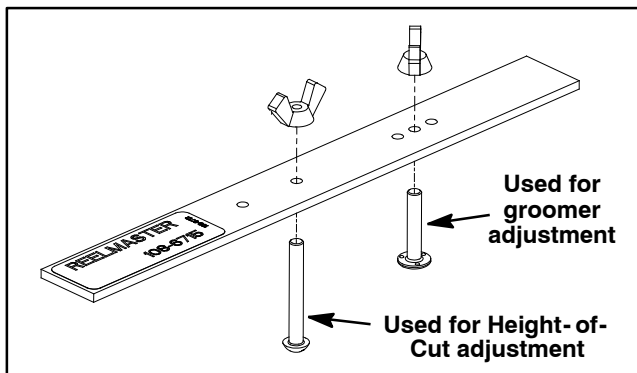


Figure 3

Cutting Reel Shim

Toro Part Number: **125-5611**

The cutting reel shim (0.002") is used to help parallel the bedknife and cutting reel.

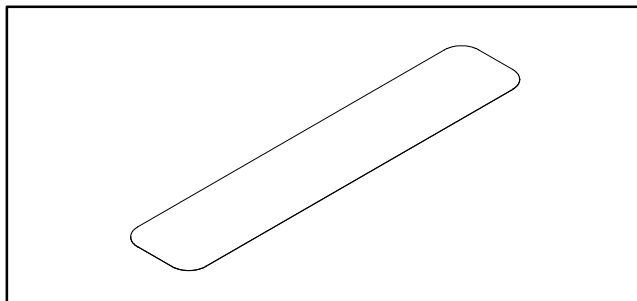


Figure 4

Cutting Performance Paper

Toro Part Number: **125-5610**

Cutting performance paper is used to test the cutting reel performance after adjusting the reel to bedknife clearance. 10 packs (30 strips per pack) of cutting performance paper are included in this part number.

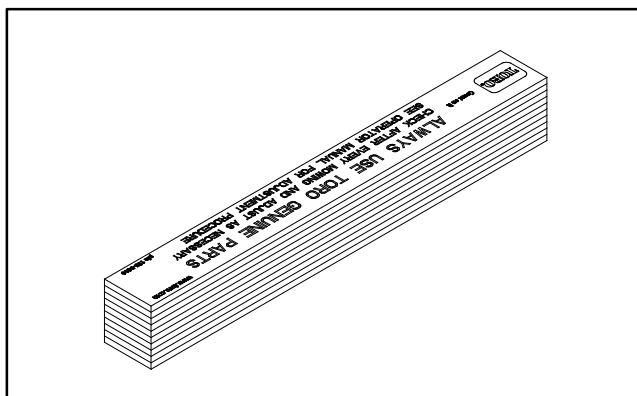


Figure 5

Bedknife Screw Tool

Toro Part Number: **TOR510880**

This screwdriver-type bit is made to fit Toro bedknife attaching screws. Use this bit with a torque wrench to secure the bedknife to the bedbar.

IMPORTANT: To prevent damage to the bedbar, DO NOT use an air or manual impact wrench with this tool.

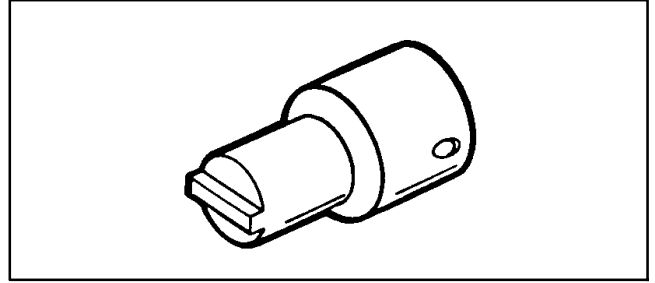


Figure 6

Handle Assembly

Toro Part Number: **29-9100**

For applying lapping compound to cutting units while keeping hands a safe distance from the rotating reel.

Components for the handle assembly are available individually as follows:

Brush	36-4310
Handle	29-9080
Handle cap	2410-18

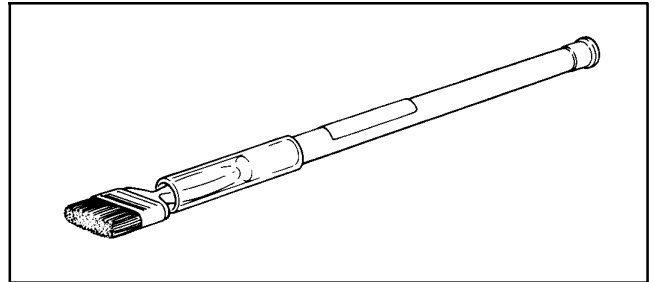


Figure 7

Cutting Unit Kickstand

Toro Part Number: **119-8010-03**

The cutting unit kickstand is used to prop up the rear of the cutting unit during service. Use of this tool stabilizes the cutting unit and prevents the bedbar adjusting screws from resting on the work surface.

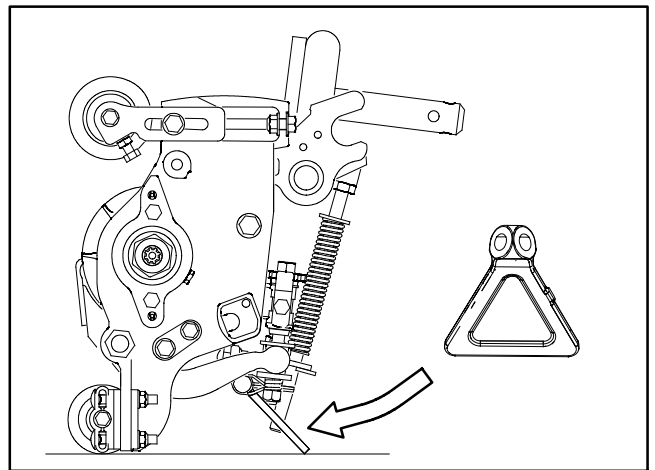


Figure 8

Spline Insert Tool

Toro Part Number: **TOR4112** (8 tooth for 5 inch reels)
TOR4074 (9 tooth for 7 inch reels)

Use spline insert tool for rotating cutting reel when motor is removed. Also use this tool for installation of threaded inserts into cutting reel shaft.

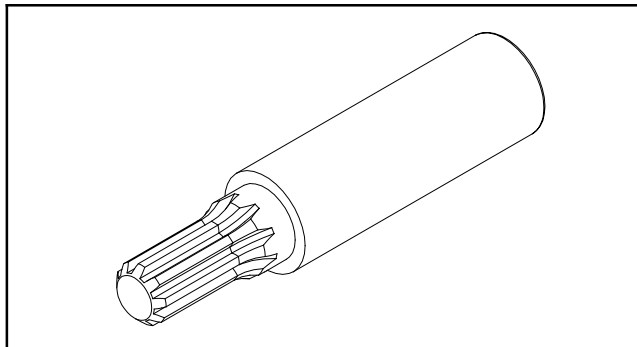


Figure 9

Rear Roller Bearing and Seal Installation Tools

Toro Part Number: **115-0803**

This tool kit is used to assemble the cutting unit rollers. Tools in this kit are also available individually as follows:

- 115-0852 Inner Seal Tool
- 115-0853 Bearing/Outer Seal Tool
- 107-8133 Bearing Installation Washer

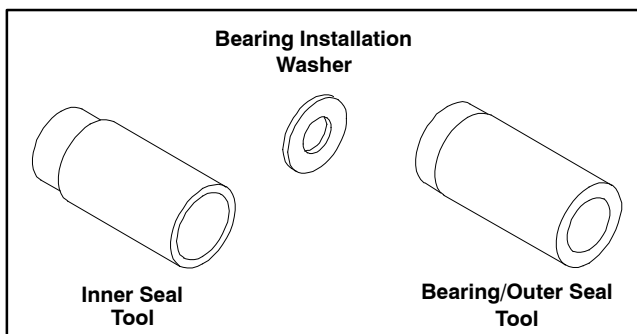


Figure 10

Plastic Plug

Toro Part Number: **2410-30** (for 5 inch reels)
94-2703 (for 7 inch reels)

This cap is used for placement into the cutting unit side plate when the cutting reel motor is removed. It prevents dirt and debris from entering the cutting reel bearing area.

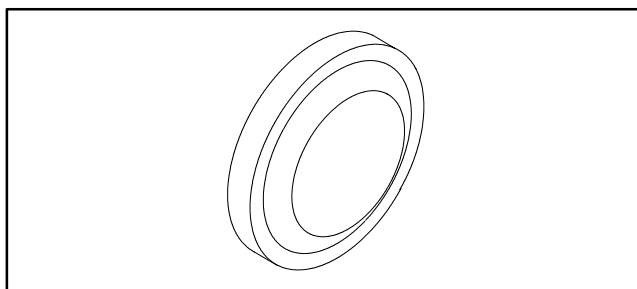


Figure 11

Pulley Alignment Tool

Toro Part Number: **114-5446**

Use pulley alignment tool to verify alignment of groomer and/or rear roller brush drive and driven pulleys.

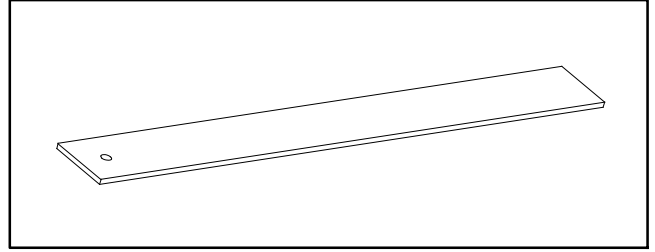


Figure 12

Diameter/Circumference Measuring Tape

Toro Part Number: **TOR6023**

Spring steel measuring tape for accurately measuring the circumference and outside diameter of cutting reel and other spherical components. Tape calibration is in fixed inch readings (no adjustments).



Figure 13

Turf Evaluator Tool

Toro Model Number: **04399**

Many turf discrepancies are subtle and require closer examination. In these instances, the Turf Evaluator grass viewing tool is helpful. It can assist turf managers and service technicians in determining causes for poor reel mower performance and in comparing the effective height-of-cut of one mowed surface to another. This tool should be used with the Toro Guide to Evaluation Reel Mower Performance and Using the TurfEvaluator (Toro part no. 97931SL)



Figure 14

Factors That Can Affect Cutting Performance

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the cutting unit. It is important to remember that the lower the height-of-cut, the more critical these factors are.

Refer to the Cutting Unit’s Operator’s Manual for detailed cutting unit adjustment procedures. For cutting unit repair information, refer to the Service and Repairs section of this chapter.

NOTE: For additional information regarding cutting unit troubleshooting, see **Aftercut Appearance Troubleshooting Aid (Toro part no. 00076SL)**.

Factor	Possible Problem/Correction
Tire pressure	Check tire pressure of all traction unit tires. Adjust tire pressure as necessary.
Engine speed	For best cutting performance and appearance, engine should be run at maximum governed speed during machine operation (use InfoCenter Display to check engine speed).
Reel speed	<p>All cutting reels must rotate at the same speed (within 100 rpm) (use InfoCenter Display to check reel speed).</p> <p>All cutting units must have equal bedknife to reel and height-of-cut adjustments.</p> <p>Make sure that reel speed selection is correct (use InfoCenter Display to check and adjust reel speed).</p>
Reel bearing condition	<p>Check reel bearings for wear and replace if necessary.</p> <p>See Reel Assembly in the Service and Repairs section of this chapter.</p>
Bedknife to reel adjustment	Check bedknife to reel contact daily. The bedknife must have light contact across the entire reel. No contact will dull the cutting edges. Excessive contact accelerates wear of both edges. Quality of cut is adversely affected by both conditions (see Bedknife to Reel Adjustment in the Cutting Unit Operator’s Manual).

Factor	Possible Problem/Correction
<p>Reel and bedknife sharpness</p> <p>NOTE: After grinding the reel and/or bedknife, check the reel to bedknife contact again after cutting two (2) fairways. During this initial use, any burrs will be removed from reel and bedknife which may create improper reel to bedknife clearance and thus accelerate wear. This practice of re- checking the reel to bedknife contact after grinding will extend the longevity of the sharpness of the edge of the reel and the bedknife.</p>	<p>A reel and/or bedknife that has rounded cutting edges or “rifling” (grooved or wavy appearance) cannot be corrected by tightening the bedknife to reel contact. Grind cutting reel to remove taper and/or rifling. Grind bedknife to sharpen and/or remove rifling.</p> <p>The most common cause of rifling is bedknife to reel contact that is too tight.</p> <p>Dull cutting edges must be corrected by grinding the bedknife and cutting reel (see Preparing Reel for Grinding in the Service and Repairs section of this chapter).</p> <p>A new bedknife must be ground flat (within 0.002”) after installation to the bedbar. Backlapping may be required to properly mate the reel and bedknife after installation into the cutting unit.</p> <p>NOTE: On cutting units equipped with optional bedknives, slightly dull cutting edges may be corrected by backlapping (see Backlapping in the Service and Repairs section of this chapter).</p>
<p>Rear roller adjustment</p>	<p>Adjust the rear roller brackets to correct position depending on the height- of- cut range and aggressiveness of cut that is desired.</p> <p>See Rear Roller Adjustment in the Cutting Unit Operator’s Manual.</p>
<p>Height- of- cut</p>	<p>“Effective” or actual height- of- cut depends on the cutting unit weight and turf conditions. Effective height- of- cut will be different from the bench set height- of- cut.</p> <p>See Height- of- Cut Adjustment in the Cutting Unit Operator’s Manual.</p>
<p>Proper bedknife selection for height- of- cut desired</p>	<p>If the bedknife is incorrect for effective height- of- cut, poor quality of cut will result.</p> <p>See Cutting Unit Operator’s Manual for bedknife options.</p>
<p>Stability of bedbar</p>	<p>Make sure bedbar pivot bolts are seated securely. Check condition of the bushings in the side plates.</p> <p>See Bedbar Removal and Installation in the Service and Repairs section of this chapter.</p>
<p>Number of reel blades</p>	<p>Use correct number of reel blades for clip frequency and optimum height- of- cut range.</p> <p>Refer to Clip Chart in Traction Unit Operator’s Manual.</p>

Factor	Possible Problem/Correction
Cutting unit alignment and carrier frame ground following	Check carrier frames and lift arms for damage, binding conditions or bushing wear. Repair if necessary.
Roller condition and roller type	<p>Make sure rollers rotate freely. Repair roller bearings as necessary.</p> <p>See Roller Service in the Service and Repairs section of this chapter.</p> <p>Refer to Cutting Unit Operator's Manual for roller options.</p>
Turf compensation spring adjustment	Refer to Traction Unit Operator's Manual for adjustment procedure.
Rear lift arm counterbalance spring adjustment	Refer to Traction Unit Operator's Manual for adjustment procedure.
Cutting unit accessories	A variety of cutting unit accessories are available that can be used to enhance aftercut appearance. Refer to Cutting Unit Operator's Manual for a listing of available accessories.

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Set Up and Adjustments

Characteristics



CAUTION

Never install or work on the cutting units or lift arms with the engine running. Always stop engine and remove key first.

Also, before installing, removing or working on the cutting units, disconnect the cutting units from the electrical power supply by separating the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).

The dual knob bedknife- to- reel adjustment system incorporated in this cutting unit simplifies the adjustment procedure needed to deliver optimum mowing performance. The precise adjustment possible with this design gives the necessary control to provide a continual self- sharpening action. This feature maintains sharp cutting edges, assures good quality of cut and greatly reduces the need for routine backlapping.

In addition, the rear roller positioning system allows for various height-of-cut ranges and aggressiveness of cut selections.

If a cutting unit is determined to be out of adjustment, complete the following procedures in the specified order to adjust the cutting unit properly.

1. Adjust the bedknife parallel to the reel.
2. Determine desired height-of-cut range and install rear roller mounting shim(s) accordingly.
3. Adjust the height-of-cut.

See Cutting Unit Operator's Manual for cutting unit adjustment procedures for your Reelmaster.

Leveling Rear Roller

The precision machined components of the cutting unit frame keep the rear roller and cutting reel in alignment (parallel). If the side plates are disassembled or as the cutting reel wears, a limited amount of side plate adjustment is possible to make sure that the cutting unit is properly aligned.

1. Place the assembled cutting unit on a surface plate.
2. Make sure that bedknife is properly adjusted to cutting reel.
3. Using the surface plate, check if rear roller is level to cutting reel by using a 0.005" (0.13 mm) shim at each end of rear roller. If the shim will pass under the roller at one end but not the other, a frame adjustment should be made.

NOTE: Cutting units with 5" diameter reel use two (2) shoulder bolts to secure side plates to frame. Cutting units with 7" diameter reel use three (3) shoulder bolts to secure side plates to frame.

4. Loosen, but do not remove, shoulder bolts that secure the side plate to the frame opposite the side that is not level (Fig. 15).

5. Adjust the position of the side plate to parallel the rear roller and cutting reel. Then, tighten the shoulder bolts to a torque from **27 to 33 ft-lb (37 to 44 N-m)**.

6. After tightening the side plate, recheck the rear roller. If necessary, loosen and adjust second side plate.

7. If rear roller is still not level after adjusting both side plates, check to see if cutting reel is tapered (see Preparing Reel for Grinding in the Service and Repairs section of this chapter). If cutting reel is not tapered and rear roller is not level, a 0.010" shim (part number 107-4001) is available to allow additional rear roller adjustment. The shim would be used on one side of the rear roller and should be installed between the rear roller bracket and roller shim (Fig. 16).

8. After leveling rear roller, complete cutting unit set-up and adjustment sequence.

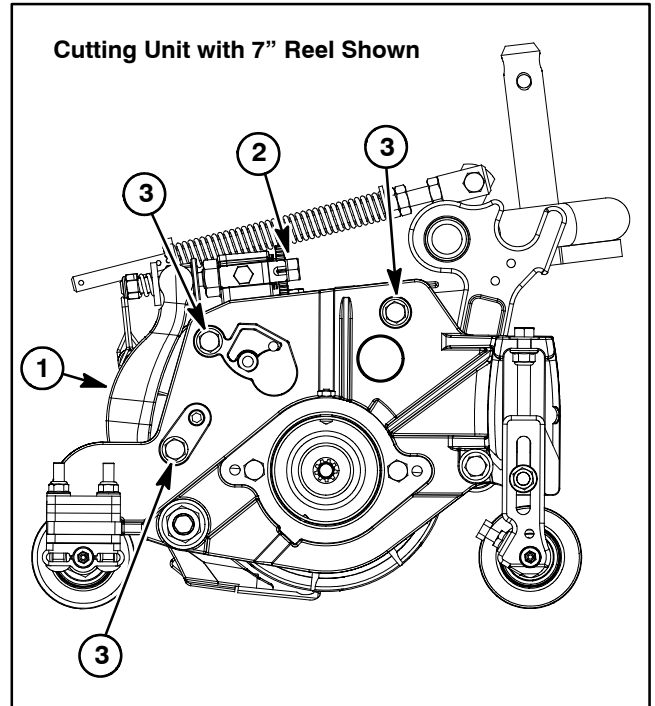


Figure 15

- | | |
|--------------------|------------------|
| 1. Bedbar | 3. Shoulder bolt |
| 2. Bedbar adjuster | |

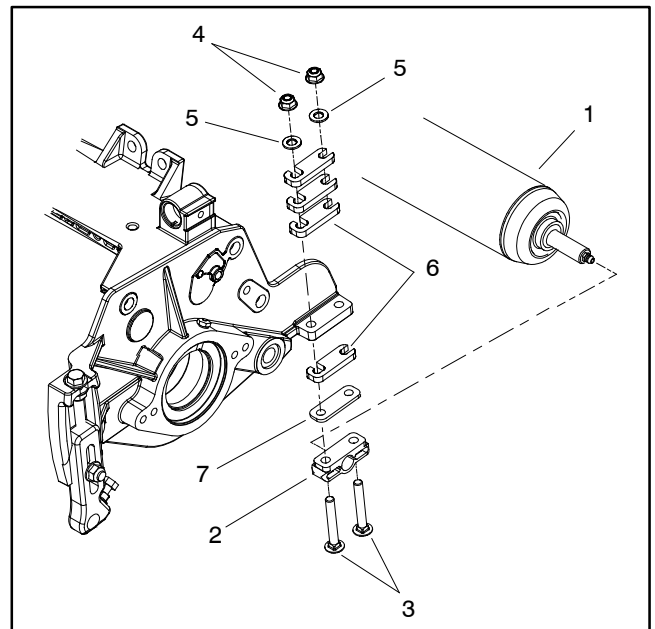


Figure 16

- | | |
|-------------------------|----------------------------|
| 1. Rear roller assembly | 5. Washer |
| 2. Rear roller bracket | 6. Roller shim |
| 3. Carriage screw | 7. 0.010" shim (if needed) |
| 4. Flange nut | |

Service and Repairs

Cutting Reel Motor

NOTE: If electrical problems exist with a cutting reel motor, a fault should have occurred that would be indicated by a fault code on the InfoCenter Display. Before considering that reel motor service work is necessary, check for any existing fault codes that indicate problems with a reel motor.

IMPORTANT: When performing service or maintenance on the cutting reel motors, take care to not damage the motors or electrical connections.

For information on removal, installation and service of the cutting unit motors, see Cutting Reel Motor and Cutting Reel Motor Service in the Service and Repairs section of Chapter 5 - Electrical System.

The cutting unit side plates (Fig. 19) have threaded inserts at the locations used for the cap screws that secure the reel motor. Check the condition of the threaded inserts whenever the cutting reel motor is removed and replace inserts if damage is found. Inserts should be torqued from **35 to 40 ft-lb (48 to 54 N-m)** during installation.

For proper lubrication of the reel motor splines, a grease fitting (item 3 in Fig. 19) must be installed in the cutting unit side plate on the reel motor side of the cutting unit. On the non-drive side plate, a set screw (item 4 in Fig. 19) should be installed so that it is flush with the side plate surface.

NOTE: Refer to Figure 18 for correct placement of cutting unit reel motors and weights.

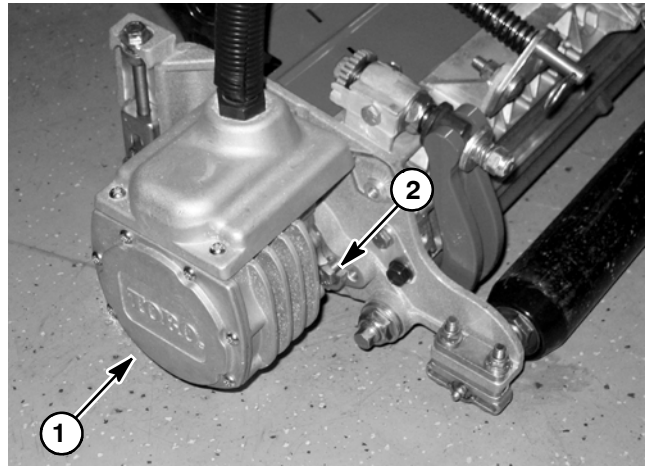


Figure 17

- 1. Cutting reel motor
- 2. Cap screw (2 used)

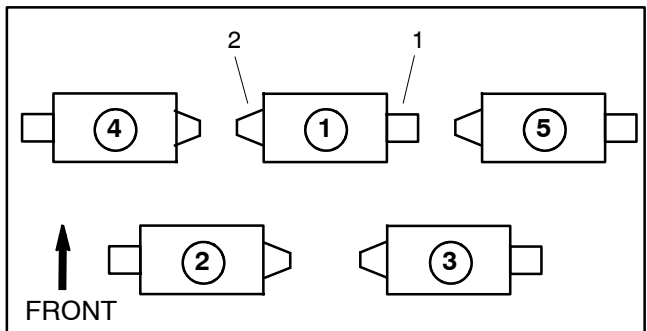


Figure 18

- 1. Reel motor location
- 2. Weight location

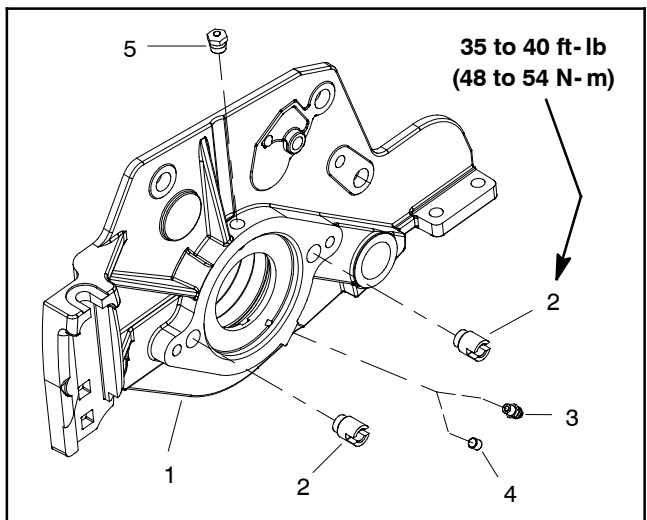


Figure 19

- 1. Side plate (LH shown)
- 2. Threaded insert
- 3. Grease fitting
- 4. Set screw
- 5. Relief fitting

Backlapping



DANGER

TO AVOID PERSONAL INJURY OR DEATH:

- Never place hands or feet in the reel area while the engine is running or if the 48 VDC battery pack is connected. Disconnect the cutting units from the electrical power supply by separating the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).
- While backlapping, the reels may stall and then restart.
- Do not attempt to restart reels by hand or foot.
- Do not adjust reels while the engine is running or if the 48 VDC battery pack is connected.
- If a reel stalls, stop engine and separate the 48 VDC battery disconnect before attempting to clear the reel.

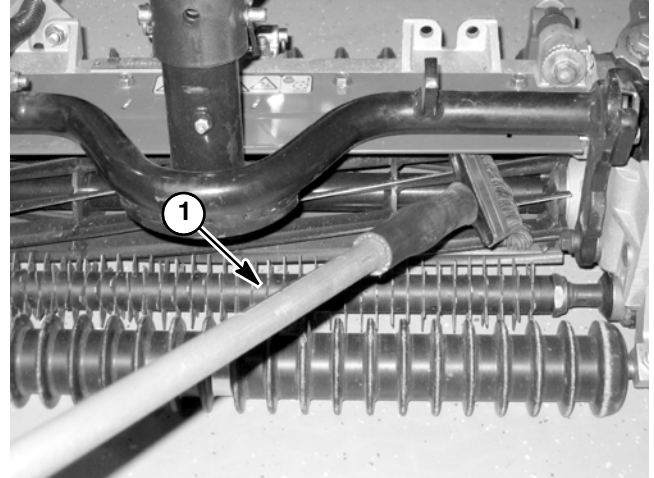


Figure 20

1. Long handle brush

NOTE: Instructions and procedures on backlapping are available in the Traction Unit Operator's Manual and the Toro General Service Training Book, Reel Mower Basics (part no. 09168SL).

Bedbar Assembly

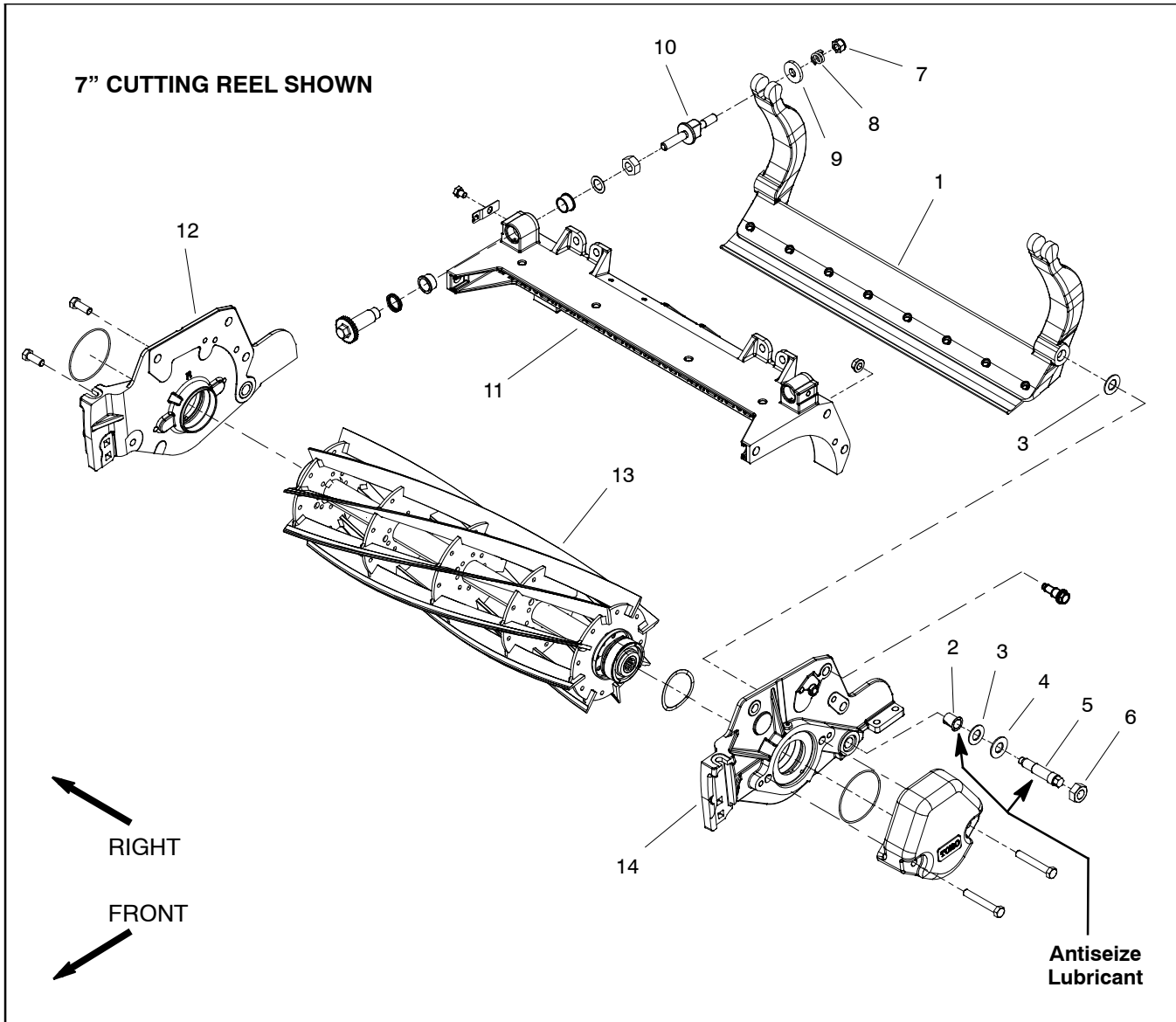


Figure 21

- | | | |
|-------------------------------|------------------------------------|---------------------------|
| 1. Bedbar assembly | 6. Lock nut (2 used) | 11. Cutting unit frame |
| 2. Flange bushing (4 used) | 7. Lock nut (2 used) | 12. RH side plate |
| 3. Plastic washer (4 used) | 8. Compression spring (2 used) | 13. Cutting reel assembly |
| 4. Metal washer (2 used) | 9. Washer (2 used) | 14. LH side plate |
| 5. Bedbar pivot bolt (2 used) | 10. Bedbar adjuster screw (2 used) | |

Bedbar Removal (Fig. 21)

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. To prevent unexpected reel motor operation, disconnect motors from the electrical power supply by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).

3. Remove the cutting unit from the machine. Use the cutting unit kickstand to support the cutting unit (see Special Tools in this chapter).

4. Loosen the lock nuts (item 7) on the end of each bedbar adjuster assembly until washer (item 9) is loose.

5. Loosen the lock nuts (item 6) on each bedbar pivot bolt (item 5).

6. Remove two (2) bedbar pivot bolts (item 5), two (2) metal washers (item 4) and four (4) plastic washers (item 3) from the cutting unit side plates.

	CAUTION
<p>Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when handling the bedbar.</p>	

7. Remove bedbar assembly from cutting unit.

8. Inspect flange bushings (item 2) and rubber bushings in side plates for wear or damage. Remove bushings and replace if necessary.

Bedbar Installation (Fig. 21)

1. If rubber bushing was removed from either cutting unit side plate, install a new bushing. The bushing should be installed flush with the inside of the side plate (Fig. 22).

2. If removed, install the flange bushings (item 2) with flange facing outward. Apply antiseize lubricant to inside of flange bushing.

3. Apply antiseize lubricant to the bedbar threads and the shoulder area of each bedbar pivot bolt.

4. Slide one metal washer (item 4) and one plastic washer (item 3) onto each bedbar pivot bolt.

	CAUTION
<p>Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when handling the bedbar.</p>	

5. Position bedbar into cutting unit. Make sure that the top of each bedbar arm is between washer (item 9) and adjuster screw flange (item 10).

6. Position a plastic washer (item 3) between bedbar and each cutting unit side plate (Fig. 22).

7. Install the bedbar pivot bolt assemblies. Make sure that plastic washers are not caught on the threads of the pivot bolts. Tighten each bedbar pivot bolt from **27 to 33 ft-lbs (37 to 44 N-m)**.

8. Tighten both lock nuts (item 6) until outside metal washer just stops rotating. Do not over tighten the lock nuts as this can distort the side plates and affect reel bearing adjustment. The plastic washer between the bedbar and side plate should be loose.

9. Tighten the lock nut (item 7) on each bedbar adjuster assembly until the adjuster spring is fully compressed, then loosen lock nut 1/2 turn.

10. Adjust cutting unit (see Cutting Unit Operator's Manual).

11. Install cutting unit to machine.

12. Plug the 48 VDC battery disconnect back in before operating the machine.

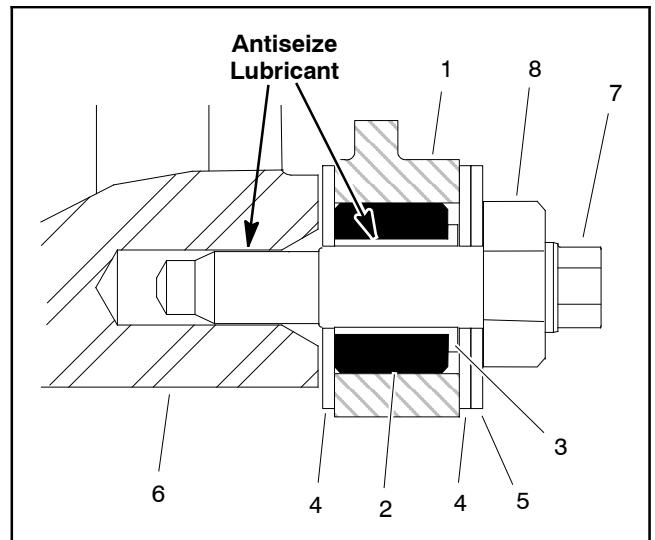


Figure 22

- | | |
|---------------------------|----------------------|
| 1. Cutting unit sideplate | 5. Washer (metal) |
| 2. Rubber bushing | 6. Bedbar |
| 3. Flange bushing | 7. Bedbar pivot bolt |
| 4. Washer (plastic) | 8. Lock nut |

Cutting Units

Bedknife Replacement and Grinding

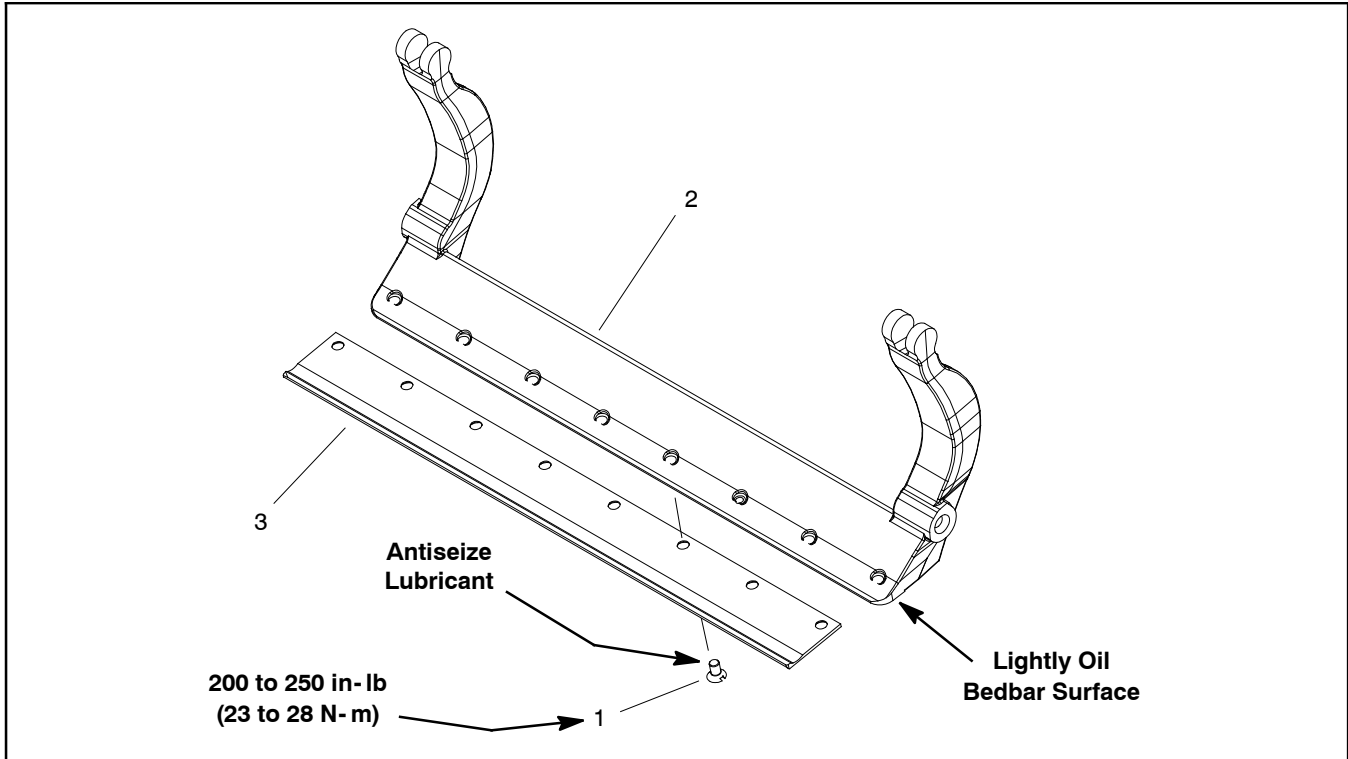


Figure 23

1. Screw (8 used)

2. Bedbar

3. Bedknife

Bedknife Removal

1. Remove bedbar from cutting unit (see Bedbar Assembly in this section).
2. Remove screws from bedbar using a socket wrench and bedknife screw tool (see Special Tools in this chapter). Discard screws. Remove bedknife from the bedbar (Fig. 23).

Bedknife Installation

1. Use scraper to remove all rust, scale and corrosion from bedbar surface. Lightly oil bedbar surface before installing bedknife.

2. Make sure that screw threads in bedbar (5/16-18UNC-2A) are clean. Apply antiseize lubricant to the threads of new screws. Take care to keep antiseize lubricant from taper on screw heads.

IMPORTANT: Do not use an impact wrench to tighten screws into the bedbar.

3. Use new screws to secure bedknife to bedbar. Install all screws but do not tighten fully. Then, using a torque wrench and bedknife screw tool, torque screws from **200 to 250 in-lb (23 to 28 N-m)**. Use a torquing pattern working from the center toward each end of the bedknife (Fig. 24).

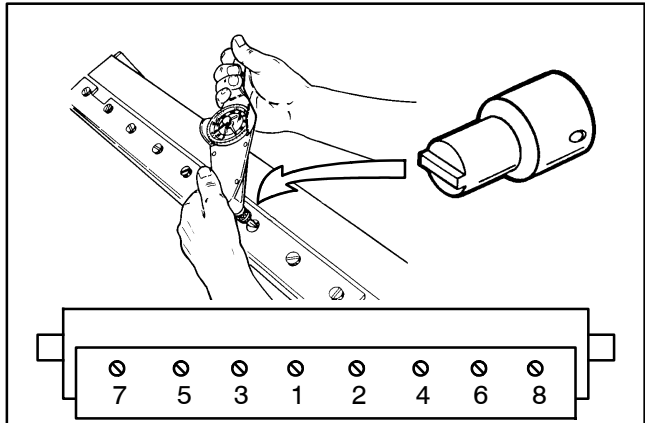


Figure 24

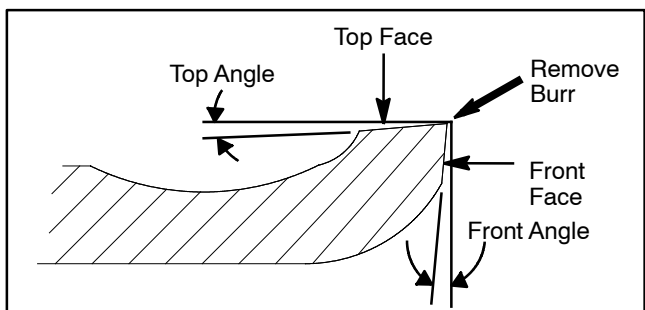


Figure 25

4. After installing bedknife to bedbar, grind bedknife.

Bedknife Grinding

Since there can be variations in the mounting surface of the bedbar, a new bedknife will not be perfectly flat after it is installed to the bedbar. Because of this, it is necessary to grind a new bedknife after installing it to the bedbar. Follow the existing angle that was ground into the bedknife and grind only enough to make sure the top surface of the bedknife is true (Fig. 25).

IMPORTANT: When grinding the bedknife, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder. Also, clean and dress grinding stone often during the grinding process.

1. Use Cutting Unit Operator's Manual, Toro General Service Training Book, Reel Mower Basics (part no. 09168SL) and grinder manufacturer's instructions for bedknife grinding information.

2. After grinding bedknife, check lead-in chamfer on bedknife (see Cutting Unit Operator's Manual).

3. After bedknife grinding is complete, install bedbar to cutting unit (see Bedbar Assembly in this section).

NOTE: After grinding the reel and/or bedknife, check the reel to bedknife contact again after cutting two (2) fairways. During this initial use, any burrs will be removed from reel and bedknife which may create improper reel to bedknife clearance and thus accelerate wear. This practice of re-checking the reel to bedknife contact after grinding will extend the longevity of the sharpness of the edge of the reel and the bedknife.

Bedknife Grinding Specifications (see Fig. 25)	
Bedknife Top Angle	10°
Bedknife Front Angle	5°
Extended Bedknife Front Angle	10°

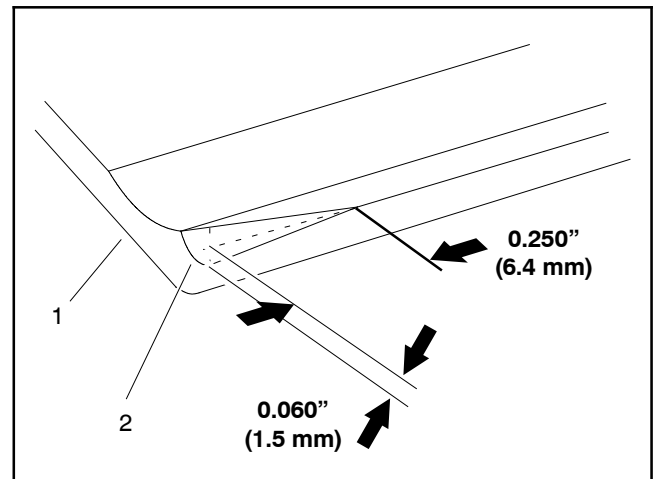


Figure 26

1. Bedknife

2. Lead-in chamfer

Bedbar Adjuster Service

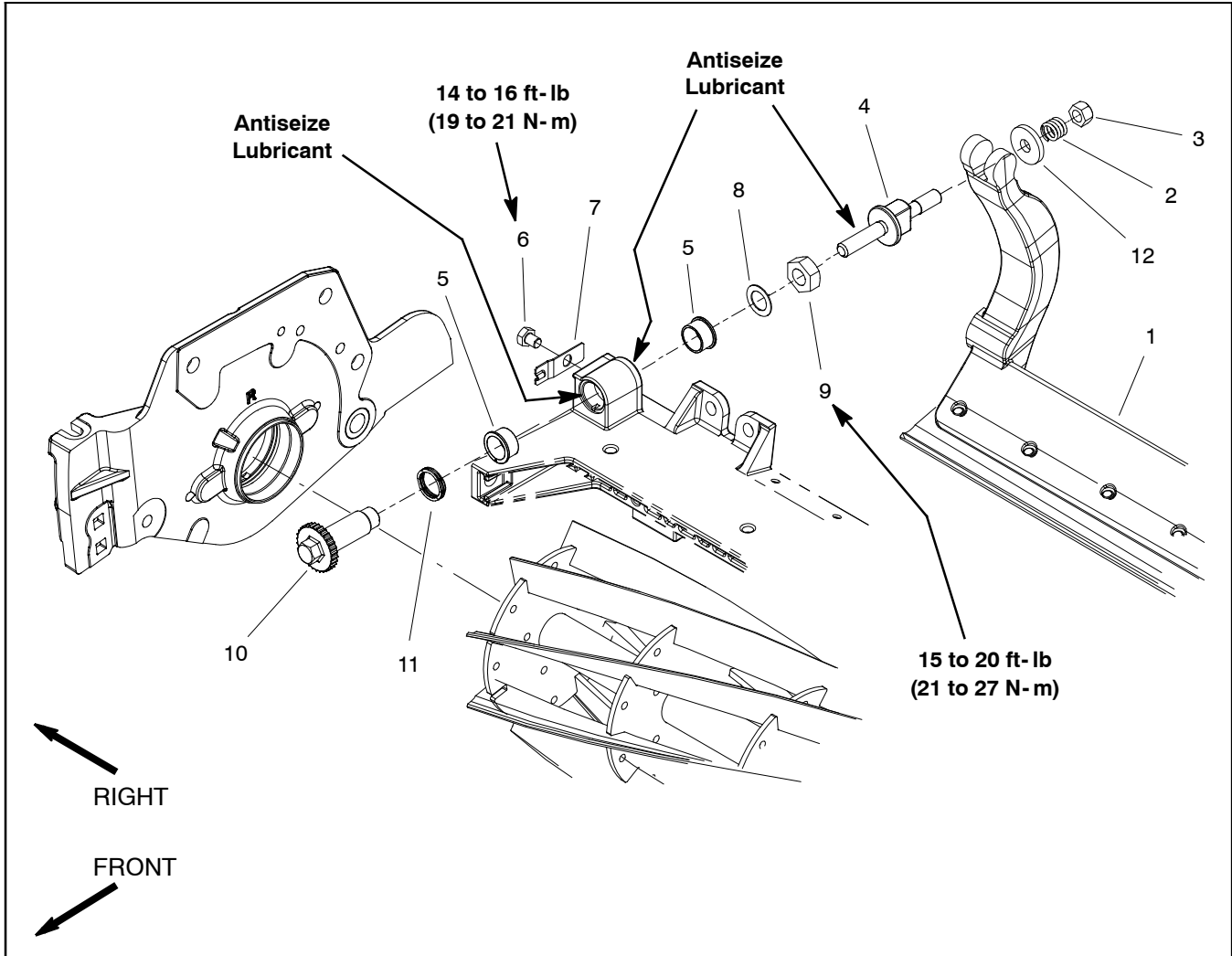


Figure 27

- | | | |
|--------------------------|----------------------------------|---------------------------|
| 1. Bedbar assembly | 5. Keyed flange bushing (2 used) | 9. Lock nut |
| 2. Compression spring | 6. Cap screw | 10. Bedbar adjuster shaft |
| 3. Lock nut | 7. Detent | 11. Wave washer |
| 4. Bedbar adjuster screw | 8. Flat washer | 12. Washer |

Removal (Fig. 27)

1. Remove lock nut (item 3), compression spring (item 2) and washer (item 12) from bedbar adjuster screw (item 4).

2. Remove bedbar (see Bedbar Assembly in this section).

NOTE: Inside threads in bedbar adjuster shaft (item 10) are left-hand threads.

3. Unscrew bedbar adjuster screw (item 4) from the bedbar adjuster shaft (item 10).

4. Remove bedbar adjuster shaft (item 10) from cutting unit frame:

A. Remove lock nut and flat washer from adjuster shaft.

B. Slide adjuster shaft and wave washer from cutting unit frame.

5. Inspect keyed flange bushings (item 5) in cutting unit frame and remove if necessary.

6. If detent (item 7) is damaged, remove it from cutting unit side plate by removing the cap screw (item 6).

Installation (Fig. 27)

1. If detent (item 7) was removed, secure detent to cutting unit side plate with cap screw. Torque cap screw from **14 to 16 ft-lb (19 to 21 N-m)**.

2. If keyed flange bushings (item 5) were removed from cutting unit frame, apply antiseize lubrication to bushing bore in cutting unit frame. Align key on bushing to slot in frame and slide bushing into frame.

3. Install bedbar adjuster shaft (item 10) to cutting unit frame:

A. Slide wave washer onto bedbar adjuster shaft and then slide adjuster shaft into keyed flange bushing in cutting unit frame.

B. Secure adjuster shaft with flat washer and lock nut. Tighten lock nut to shoulder of adjuster shaft and then torque lock nut from **15 to 20 ft-lb (21 to 27 N-m)**.

NOTE: Inside threads in bedbar adjuster shaft (item 10) are left-hand threads.

4. Apply antiseize lubricant to threads of bedbar adjuster screw (item 4) that fit into bedbar adjuster shaft (item 10). Thread bedbar adjuster screw into adjuster shaft.

5. Install bedbar (see Bedbar Assembly in this section).

6. Install washer (item 12), compression spring (item 2) and lock nut (item 3) onto bedbar adjuster screw. Tighten the lock nut on each bedbar adjuster assembly until the compression spring is fully compressed, then loosen lock nut 1/2 turn.

7. Adjust cutting unit (see Cutting Unit Operator's Manual).

Cutting Reel Assembly Removal and Installation

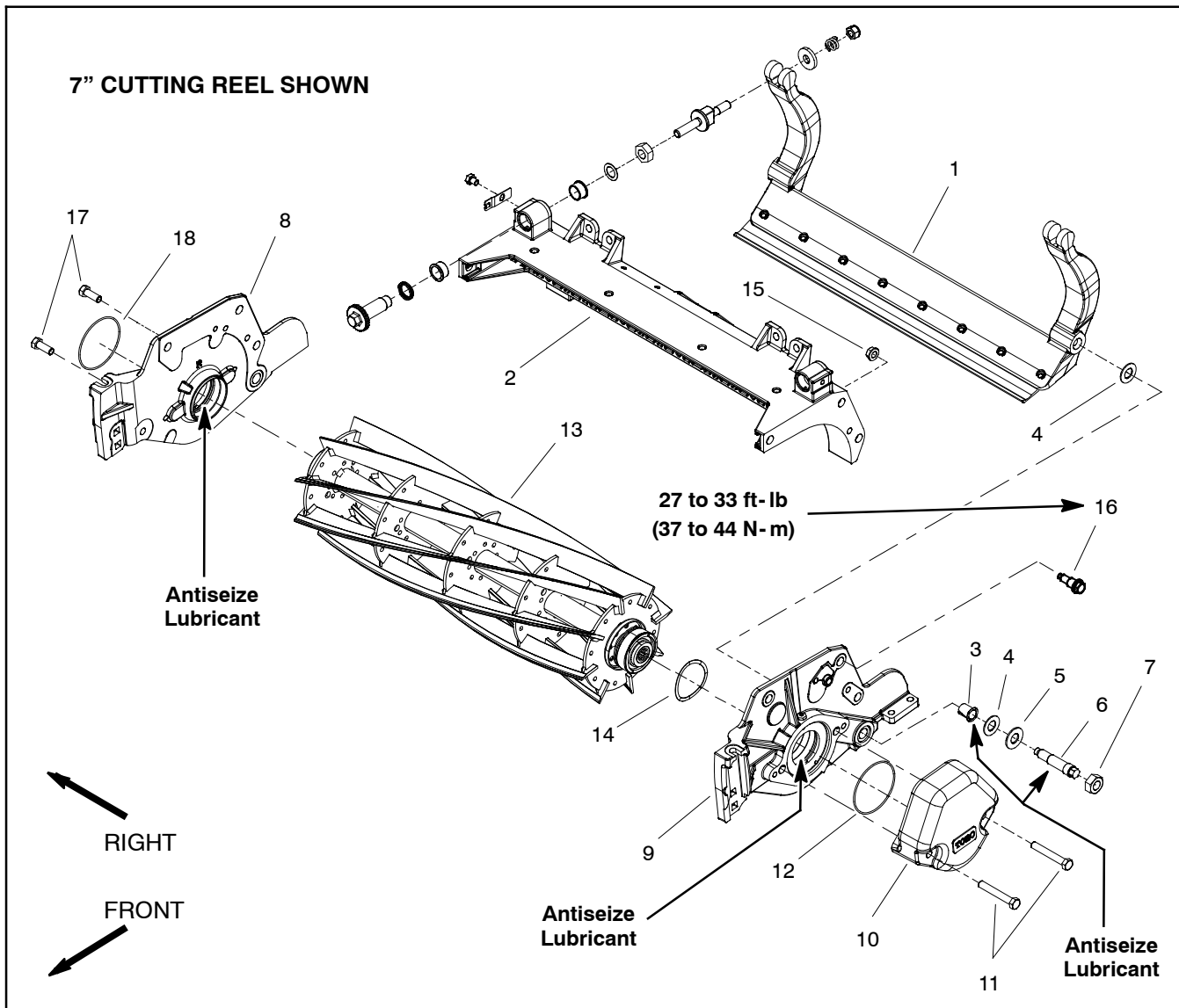


Figure 28

- | | | |
|-------------------------------|------------------------|---|
| 1. Bedbar assembly | 7. Lock nut (2 used) | 13. Cutting reel assembly |
| 2. Cutting unit frame | 8. RH side plate | 14. Wire spring |
| 3. Flange bushing (2 used) | 9. LH side plate | 15. Flange nut (3 used per side plate) |
| 4. Plastic washer (4 used) | 10. Weight | 16. Shoulder bolt (3 used per side plate) |
| 5. Metal washer (2 used) | 11. Cap screw (2 used) | 17. Cap screw (2 used) |
| 6. Bedbar pivot bolt (2 used) | 12. O-ring | 18. O-ring |

NOTE: This section provides the procedure for removing and installing the cutting reel assembly (cutting reel, spline inserts, seals and bearings) from the cutting unit. Refer to Reel Assembly Service later in this section for information on replacing cutting reel seals and bearings.

NOTE: Removal of the cutting reel requires removal of the left side plate (item 9) from the cutting unit frame. The right side plate (item 8) does not have to be removed from the frame.

Reel Assembly Removal (Fig. 28)

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.
2. To prevent unexpected reel motor operation, disconnect motors from the electrical power supply by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).
3. Remove the cutting unit from the machine and place it on a flat work area.

4. If cutting unit is equipped with a weight on LH side plate, remove the two (2) flange nuts securing the weight to the side plate and remove weight from the cutting unit. Remove and discard O-ring from weight.



CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when removing the cutting reel.

5. If cutting unit is equipped with an optional groomer or rear roller brush, remove components for those options from left hand side plate of cutting unit. See Service and Repairs section of Chapter 9 - Groomer for information on groomer disassembly. See Rear Roller Brush and Rear Roller Brush Drive System in the Service and Repairs section of this chapter for information on rear roller brush disassembly.

6. Remove the bedbar pivot bolt and washers from the LH side plate. Note location of plastic and steel washers for assembly purposes (see Bedbar Assembly in this section).

7. Loosen fasteners that secure front and rear rollers to LH side plate (see Front Roller and Rear Roller in this section).

8. Remove cap screw and flat washer that secure rear grass shield to LH side plate (Fig. 29 for 7" cutting units or Fig. 30 for 5" cutting unit).

9. Remove fasteners that secure frame spacer, washer(s) and carrier frame to LH side plate (Fig. 29 for 7" cutting units or Fig. 30 for 5" cutting unit). Note the number of washers that exist between LH side plate and carrier frame for assembly purposes.

10. Support cutting reel to keep it from shifting or falling.

NOTE: Side plates on 5" cutting reel attach to cutting unit frame with two (2) shoulder bolts and flange nuts. Side plates on 7" cutting reel use three (3) shoulder bolts and flange nuts.

11. Remove shoulder bolts (item 8) and flange nuts (item 24) that secure the LH side plate to cutting unit frame.

12. Carefully remove the LH side plate from the reel shaft, rollers, bedbar, carrier frame and cutting unit frame. Locate and remove flat wire spring (item 14 in Fig. 28).

13. Carefully slide the cutting reel assembly from the RH side plate.

14. Inspect and service cutting reel assembly (see Cutting Reel Assembly Service in this section).

Reelmaster 5010-H

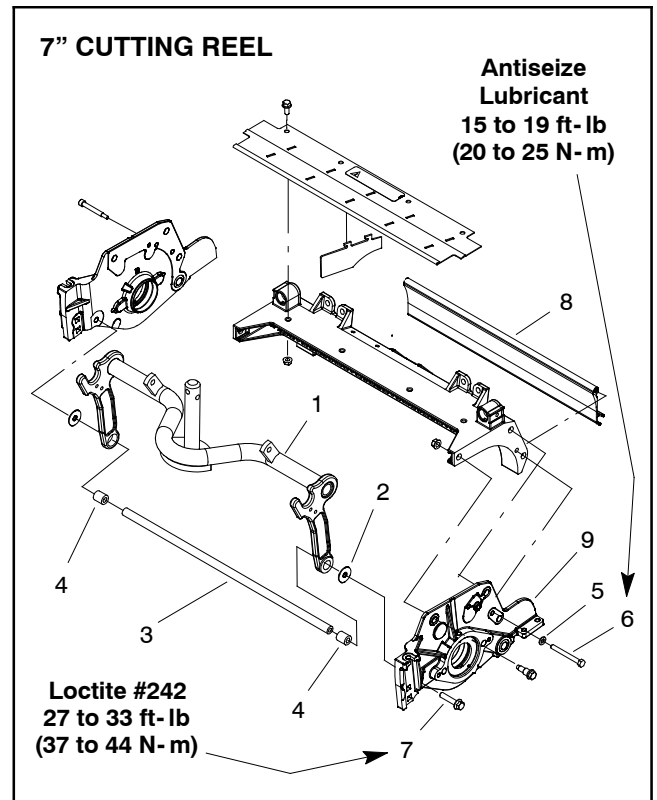


Figure 29

- | | |
|------------------|----------------------|
| 1. Carrier frame | 6. Cap screw |
| 2. Washer | 7. Flange head screw |
| 3. Support tube | 8. Rear grass shield |
| 4. Frame spacer | 9. LH side plate |
| 5. Flat washer | |

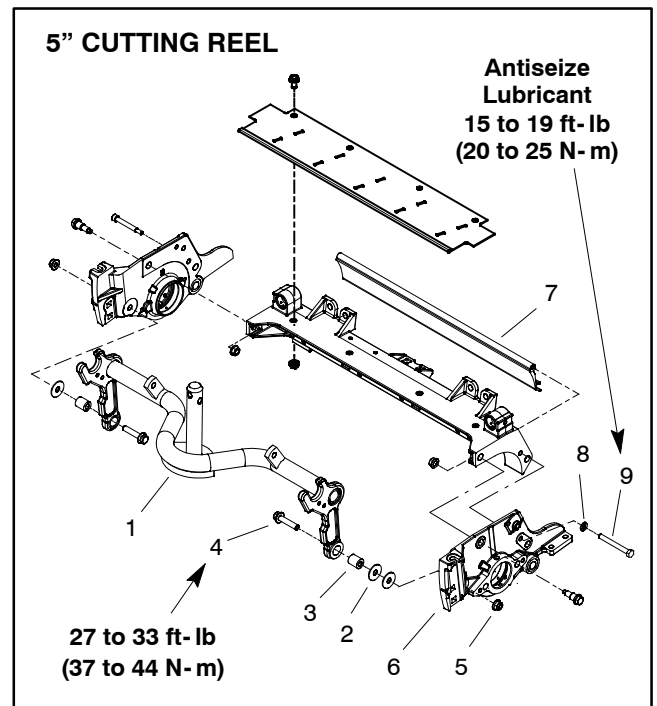


Figure 30

- | | |
|----------------------|----------------------|
| 1. Carrier frame | 6. LH side plate |
| 2. Washer | 7. Rear grass shield |
| 3. Frame spacer | 8. Flat washer |
| 4. Flange head screw | 9. Cap screw |
| 5. Flange nut | |

Cutting Units

Reel Assembly Installation (Fig. 28)

1. Thoroughly clean side plates and other cutting unit components. Inspect side plates for wear or damage and replace if needed.



2. Position the cutting unit on a flat work area. The rollers, bedbar, carrier frame and cutting unit frame should be attached to RH side plate.

3. Apply a thin coat of antiseize lubricant to outside of bearings on cutting reel.

4. Carefully slide the cutting reel assembly into the RH side plate. Make sure that bearing is fully seated into side plate.

5. Slide the LH side plate onto the cutting reel assembly, front roller and rear roller. Make sure that reel end in RH side plate does not shift in position.

6. Install shoulder bolts (item 8) and flange nuts (item 24) that secure the LH side plate to the cutting unit frame. Torque the shoulder bolts from **27 to 33 ft-lbs (37 to 44 N-m)**.

7. Secure carrier frame to LH side plate:

A. For 7" cutting unit (Fig. 29), apply Loctite #242 (or equivalent) to threads of flange head screw that secures support tube, frame spacer, removed washer(s) and carrier frame to LH side plate. Install screw and torque screw from **27 to 33 ft-lbs (37 to 44 N-m)**.

B. For 5" cutting unit (Fig. 30), secure carrier frame, frame spacer and removed washer(s) to LH side plate with flange head screw and flange nut. Torque screw from **27 to 33 ft-lbs (37 to 44 N-m)**.

C. After tightening flange head screw, check the clearance between the carrier frame and side plate. If clearance is more than 0.065" (1.7 mm), remove flange head screw and position additional washer(s) between carrier frame and side plate so that clearance is less than 0.065" (1.7 mm). Make sure that the carrier frame pivots freely after assembly.

8. Apply antiseize lubricant to threads of cap screw that secures rear grass shield to LH side plate (Fig. 29 for 7" cutting units or Fig. 30 for 5" cutting unit). Install cap screw and flat washer to secure rear grass shield to LH side plate. Torque screw from **15 to 19 ft-lbs (20 to 25 N-m)**.

9. Secure the bedbar assembly to LH side plate (see Bedbar Assembly in this section).

10. Secure front and rear rollers to LH side plate (see Front Roller and Rear Roller in this section).

11. Adjust cutting unit (see Cutting Unit Operator's Manual).

NOTE: The parallel position of the rear roller to the cutting reel is controlled by the precision machined frame and side plates of the cutting unit. If necessary, the cutting unit side plates can be loosened and a slight adjustment can be made to parallel the rear roller with the cutting reel (see Leveling Rear Roller in the Set-Up and Adjustments section of this Chapter).

12. If cutting unit is equipped with optional groomer or rear roller brush, install components for those options to left hand side plate of cutting unit. See Service and Repairs section of Chapter 9 - Groomer for information on groomer assembly. See Rear Roller Brush and Rear Roller Brush Drive System in the Service and Repairs section of this chapter for information on rear roller brush assembly.

13. Secure weight to cutting unit side plate with two (2) cap screws. Torque screws from **27 to 33 ft-lbs (37 to 44 N-m)**.

14. Lubricate cutting unit grease fitting until grease purges from relief valve in side plate with motor. Initial greasing may require several pumps of a hand grease gun.

15. Install cutting unit to the machine.

16. Plug the 48 VDC battery disconnect back in before operating the machine.

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Cutting
Units

Cutting Reel Assembly Service

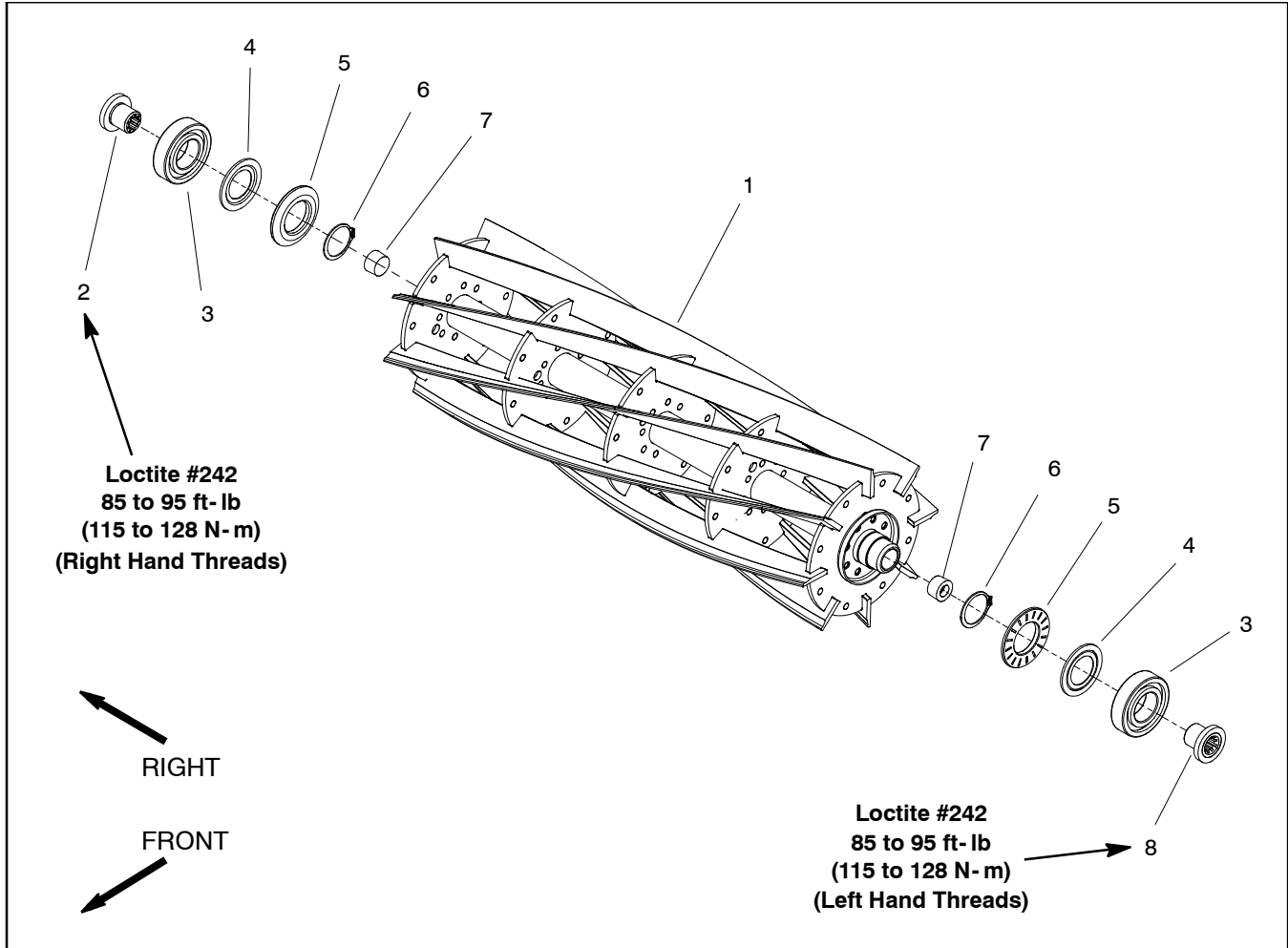


Figure 31

- | | | |
|--------------------------------|-------------------|--------------------------------|
| 1. Cutting reel | 4. Flocked seal | 7. Reel shaft plug |
| 2. Threaded insert (RH thread) | 5. Special washer | 8. Threaded insert (LH thread) |
| 3. Bearing | 6. Retaining ring | |

Disassembly of Cutting Reel (Fig. 31)

1. Remove threaded inserts (items 2 and 8) from cutting reel. The threaded insert with the groove on the face has LH threads and is in end of reel shaft identified with a groove that is just inside of reel spider (Fig. 32). Use correct spline insert tool for insert removal (see Special Tools in this chapter).
2. Slide bearings (item 3) from reel shaft.
3. Note orientation of flocked seals (item 4) for assembly purposes (flocked (red) side orientated toward bearing location). Remove flocked seals from reel shaft.
4. Note orientation of special washers (item 5) for assembly purposes (flat side toward bearing location). Carefully drive special washers from reel shaft.
5. If necessary, remove reel shaft plugs (item 7) from reel shaft.

6. Discard removed components and replace during cutting reel assembly.

Inspection of Cutting Reel (Fig. 31)

1. Check the threaded inserts for excessive wear or distortion. Replace inserts if damage is evident.
2. Inspect the reel shaft as follows. If reel damage is detected, replace reel.
 - A. Check the reel shaft for bending and distortion by placing the shaft ends in V-blocks.
 - B. Check the reel blades for bending or cracking.
 - C. Check the service limit of the reel diameter (see Preparing a Reel for Grinding in this section).

Assembly of Cutting Reel (Fig. 31)

1. If removed, install new reel shaft plugs into cutting reel shaft. Plugs should be recessed into reel shaft from **1.370" to 1.630" (34.8 to 41.4 mm)** (Fig. 33).

2. Install two (2) new retaining rings onto cutting reel shaft. Make sure that the retaining rings are fully seated into the grooves on the shaft.

3. Carefully drive special washers onto reel shaft with beveled side of washers toward reel (flat side toward bearing location). Installed washers should be tight against retaining ring and should not wobble as the reel is rotated.

IMPORTANT: The flocked seal should be installed so the flocked (red) side of the seal is toward the bearing location.

4. Slide flocked seals (flocked (red) side orientated toward bearing location) and bearings fully onto reel shaft. Flocked seals and bearings should bottom on reel shaft shoulder.

NOTE: The threaded insert with the groove on the face has LH threads and should be installed in end of reel shaft identified with a groove that is just inside of reel spider (Fig. 32).

5. Clean threads of threaded inserts and cutting reel shaft. Apply Loctite #242 (or equivalent) to threads of inserts, thread inserts into reel shaft and torque from **85 to 95 ft-lb (115 to 128 N-m)**. Use correct spline insert tool for insert installation (see Special Tools in this chapter).

6. Fill threaded insert splines with high temp Mobil XHP-222 grease or equivalent.

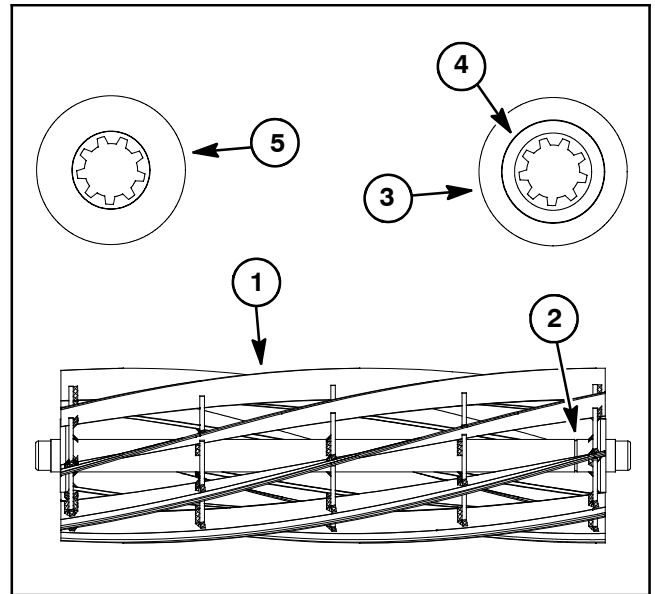


Figure 32

- | | |
|---------------------------|---------------------------|
| 1. Cutting reel | 4. Groove on face |
| 2. Reel shaft groove | 5. Insert with RH threads |
| 3. Insert with LH threads | |

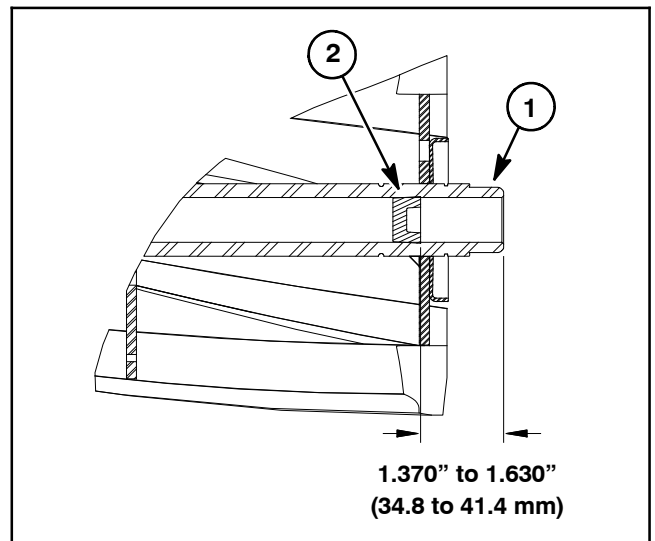


Figure 33

- | | |
|-----------------------|--------------------|
| 1. Cutting reel shaft | 2. Reel shaft plug |
|-----------------------|--------------------|

Preparing Reel for Grinding

Three (3) types of cutting reel designs are used in cutting units for Reelmaster 5010-H machines: scalloped radial reel, tapered radial reel and tapered forward swept reel. The different types of individual reel blades are shown in Figure 34. The radial reel designs have blades that are placed in line with the center of the reel shaft. The rear of the blades either have a scalloped relief or a tapered relief. The forward swept reel have blades that have a slight forward slant. The rear of the forward swept reel blades have a tapered relief.

Before grinding a reel, make sure to identify the type of reel design to make sure that grinding is correctly done.

NOTE: Before grinding a cutting reel, make sure that all cutting unit components are in good condition. Depending on type of grinder used, faulty cutting unit components can affect grinding results.

NOTE: When grinding, be careful to not overheat the cutting reel blades. Remove small amounts of material with each pass of the grinder.

Follow reel grinder manufacturer's instructions to grind cutting reel to Toro specifications (see Reel Grinding Specifications chart below). Additional reel grinding information can be found in your Cutting Unit Operator's Manual and the **Toro General Service Training Book, Reel Mower Basics (part no. 09168SL)**.

After completing the reel grinding process, adjust cutting unit (see Cutting Unit Operator's Manual).

Reel Grinding Specifications	
Reel Diameter (New)	5.060 in (128.5 mm) for 5" reel 7.060 in (179.3 mm) for 7" reel
Service Limit - Reel Diameter	4.500 in (114 mm) for 5" reel 6.600 in (168 mm) for 7" reel
Reel Shaft Diameter (OD)	1.313 in (33.3 mm)
Service Limit - Reel Diameter Taper	0.010 in (0.25 mm) for both 5" and 7" reel (Fig. 35)
Blade Land Width	0.050 to 0.060 in (1.3 to 1.5 mm)
Blade Relief Angle	30° +/- 5°

NOTE: Relief grind of cutting reel blades is necessary when blade land width exceeds 0.120" (3 mm).

NOTE: After grinding the reel and/or bedknife, check the reel to bedknife contact again after cutting two (2) fairways. During this initial use, any burrs will be removed from reel and bedknife which may create improper reel to bedknife clearance and thus accelerate wear. This practice of re-checking the reel to bedknife contact after grinding will extend the longevity of the sharpness of the edge of the reel and the bedknife.

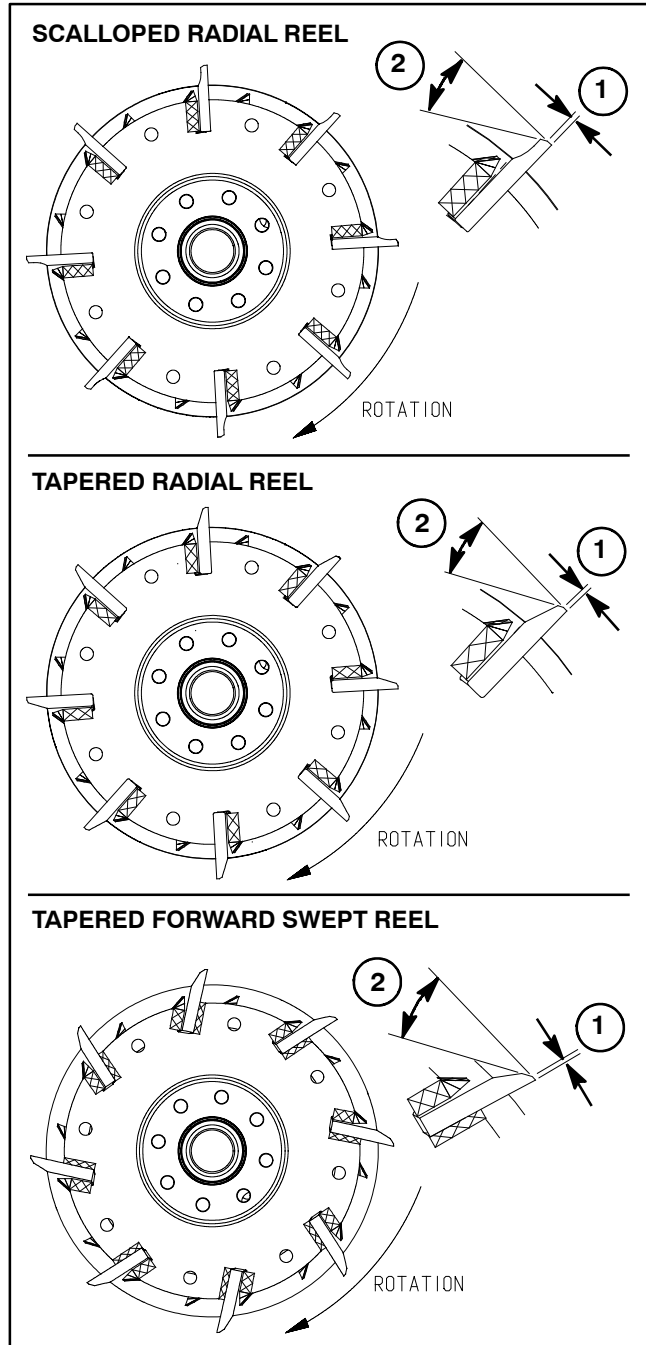


Figure 34

1. Blade land width 2. Blade relief angle

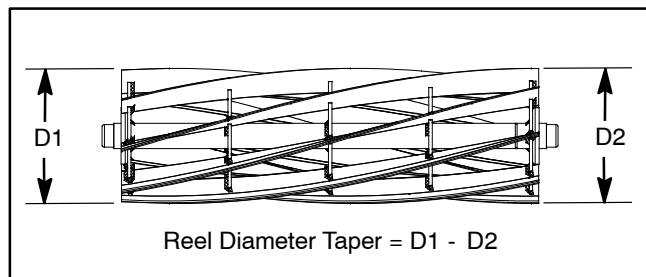


Figure 35

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Front Roller

Removal (Fig. 36)

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.
2. Remove the cutting unit from the machine and place on a level working surface. Use cutting unit kickstand (see Special Tools in this chapter) to raise front roller from work surface.
3. Loosen flange nut and cap screw securing the front roller shaft to each front height-of-cut (roller) bracket.
4. On one of the height-of-cut (roller) brackets:
 - A. Remove flange lock nut and carriage screw that secure bracket to the cutting unit side plate.
 - B. Remove the height-of-cut (roller) bracket from the cutting unit.
5. Slide the front roller assembly from the remaining height-of-cut (roller) bracket on the cutting unit.
6. If necessary, remove the second height-of-cut (roller) bracket from the cutting unit.

Installation (Fig. 36)

1. Place cutting unit on a level working surface and use cutting unit kickstand (see Special Tools in this chapter) to support cutting unit.
2. Inspect condition of cap screws (item 1) in both height-of-cut (roller) brackets. Replace cap screw(s) if necessary:
 - A. Place two (2) flat washers on cap screw and thread flange lock nut onto cap screw to a position 0.750" (19 mm) from screw head.
 - B. Apply antiseize lubricant to cap screw threads that will extend into height-of-cut (roller) bracket.
 - C. Thread cap screw into bracket.

NOTE: When assembling height-of-cut (roller) brackets to side plate, make sure that cap screw head and one washer are above adjustment flange on side plate and second washer and flange lock nut are below flange.

3. If both front height-of-cut (roller) brackets were removed from cutting unit side plate, position one of the brackets to side plate. Secure bracket to side plate with carriage screw and flange lock nut.

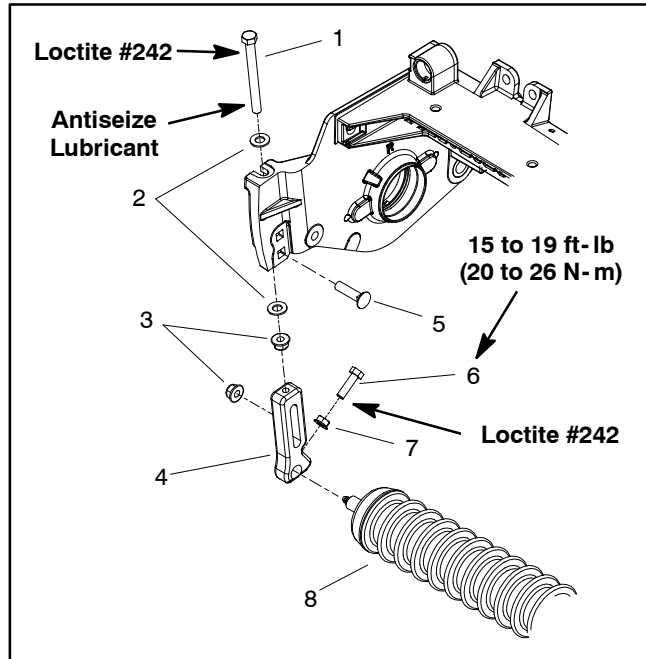


Figure 36

- | | |
|-------------------------|--------------------------|
| 1. Cap screw | 5. Carriage screw |
| 2. Flat washer | 6. Cap screw |
| 3. Flange lock nut | 7. Flange nut |
| 4. HOC (roller) bracket | 8. Front roller assembly |

4. Slide front roller shaft into bracket attached to the cutting unit. Slide second height-of-cut (roller) bracket onto the other end of roller shaft. Secure second bracket to cutting unit side plate with carriage screw and flange nut.

5. Apply Loctite #242 (or equivalent) to exposed threads of cap screw (item 1) between flange of side plate and position of flange lock nut (item 3) on cap screw. Tighten flange lock nut on cap screw and then loosen nut 1/4 to 1/2 turn. Cap screw should rotate freely with little (if any) endplay after lock nut installation.

6. Apply Loctite #242 (or equivalent) to threads of two (2) cap screws (item 6). Center front roller to the cutting reel and secure in place with two (2) cap screws. Torque cap screws from **15 to 19 ft-lb (20 to 26 N-m)**. Secure cap screws with flange nuts.

7. Lubricate front roller grease fittings.

8. Adjust cutting unit (see Cutting Unit Operator's Manual).

Rear Roller

Removal (Fig. 37)

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. Remove the cutting unit from the machine and place on a level working surface. Place support blocks under bedbar to raise rear roller from work surface.

3. Loosen two (2) flange nuts that secure the rear roller shaft to each rear roller bracket.

4. On one of the rear roller brackets:

NOTE: On cutting units equipped with optional High Height of Cut Kit, there will be additional roller shims installed between rear roller bracket and cutting unit side plate.

A. Remove flange nuts, washers and carriage screws that secure rear roller bracket and roller shims to the cutting unit side plate.

B. Remove the roller bracket and roller shims from the rear roller and cutting unit.

5. Slide the rear roller assembly from the remaining rear roller bracket on the cutting unit.

6. If necessary, remove the second rear roller bracket and roller shims from the cutting unit.

Installation (Fig. 37)

1. Place cutting unit on a level working surface.

NOTE: Refer to Cutting Unit Operator's Manual for number of roller shims required for various height of cut settings.

NOTE: A 0.010" shim (part number 107-4001) is available to allow for leveling of the rear roller (see Leveling Rear Roller in the Set-up and Adjustments section of this chapter). If necessary, this shim would be used on one side of the rear roller and should be installed between the rear roller bracket and roller shim.

2. If both rear roller brackets were removed from cutting unit side plate, position brackets and roller shims to one of the side plates. Install two (2) carriage screws and flange nuts to retain bracket in position. Do not fully tighten flange nuts.

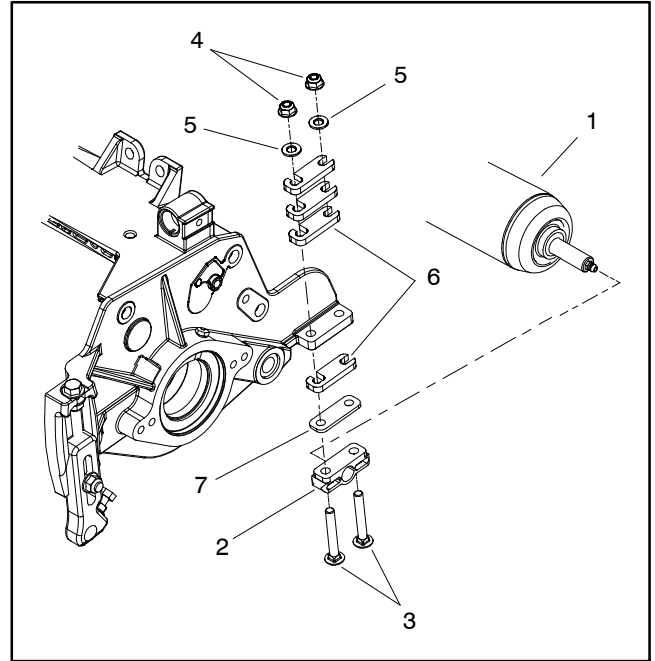


Figure 37

- | | |
|-------------------------|----------------------------|
| 1. Rear roller assembly | 5. Washer |
| 2. Rear roller bracket | 6. Roller shim |
| 3. Carriage screw | 7. 0.010" shim (if needed) |
| 4. Flange nut | |

3. Slide rear roller shaft into the rear roller bracket attached to the cutting reel. Slide second rear roller bracket onto the other end of roller shaft. Secure second roller bracket and shims to cutting unit side plate with two (2) carriage screws, washers and flange nuts. Do not fully tighten flange nuts.

4. Center rear roller to the cutting reel and secure in place by tightening four (4) flange nuts.

5. Lubricate rear roller grease fittings.

6. Adjust cutting unit (see Cutting Unit Operator's Manual).

Roller Service

Disassembly (Fig. 38)

1. Remove bearing lock nut from each end of roller shaft.
2. Loosely secure roller assembly in bench vise and lightly tap one end of roller shaft until outer seals and bearing are removed from opposite end of roller tube. Remove second set of outer seals and bearing from roller tube by tapping on opposite end of shaft. Remove shaft from roller tube.
3. Carefully remove inner seal from both ends of roller tube taking care to not damage tube surfaces.
4. Discard removed seals and bearings.
5. Clean roller shaft and all surfaces on the inside of the roller tube. Inspect components for wear or damage. Also, carefully inspect seating surface and threads of bearing lock nuts. Replace all damaged components.

Assembly (Fig. 38)

1. Install inner seals into roller tube making sure that seal lip (and garter spring) faces end of tube. Use inner seal tool (see Special Tools in this chapter) and soft face hammer to fully seat seals against roller shoulder (Fig. 39). Apply a small amount of grease around the lip of both inner seals after installation.

IMPORTANT: During assembly process, frequently check that bearings rotate freely and do not bind. If any binding is detected, consider component removal and reinstallation.

2. Install new bearing and outer seals into one end of roller tube:

A. Position a new bearing into one end of roller tube. Use bearing/outer seal tool (see Special Tools in this chapter) with a soft face hammer to fully seat bearing against roller shoulder (Fig. 40). After bearing installation, make sure that it rotates freely with no binding.

B. Apply a small amount of grease around the lip of both outer seals.

C. Install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (see Special Tools in this chapter) and soft face hammer to lightly seat seal against roller shoulder (Fig. 41). Make sure that bearing still freely rotates after seal installation.

D. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that bearing still freely rotates.

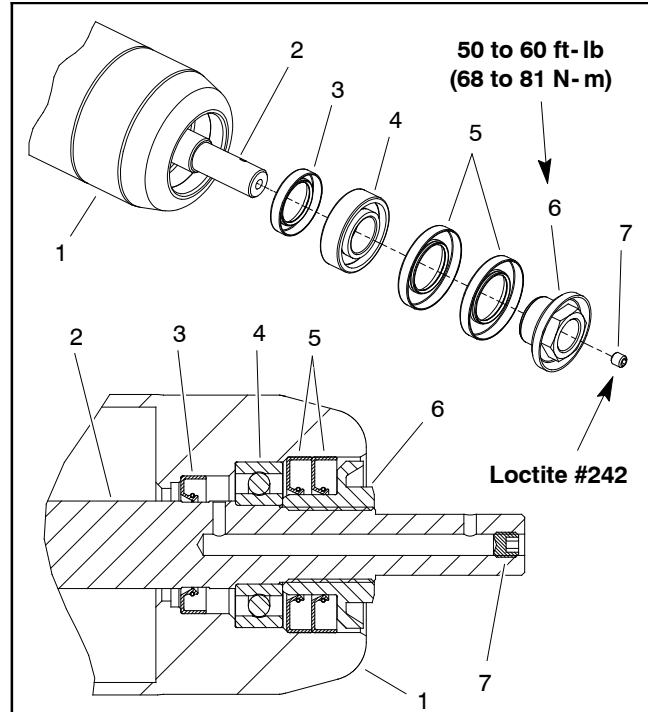


Figure 38

- | | |
|-----------------|---------------------|
| 1. Roller tube | 5. Outer seal |
| 2. Roller shaft | 6. Bearing lock nut |
| 3. Inner seal | 7. Set screw |
| 4. Bearing | |

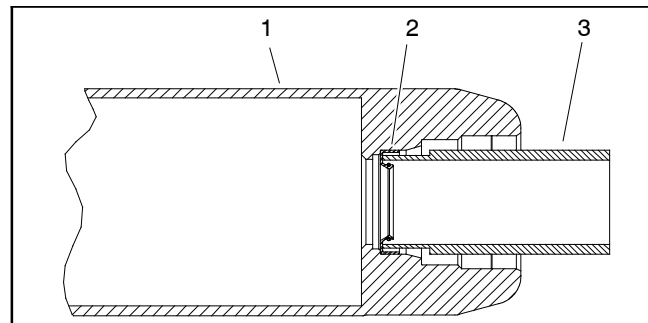


Figure 39

- | | |
|----------------|--------------------|
| 1. Roller tube | 3. Inner seal tool |
| 2. Inner seal | |

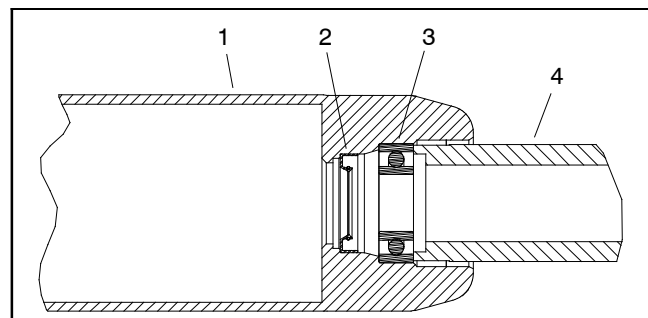


Figure 40

- | | |
|----------------|----------------------------|
| 1. Roller tube | 3. Bearing |
| 2. Inner seal | 4. Bearing/outer seal tool |

3. From the roller tube end with only the inner seal installed, carefully install the roller shaft into the roller tube. Make sure that seals are not damaged as shaft is installed.

4. Install new bearing and outer seals into second end of roller tube:

A. Position a second new bearing to roller shaft and tube. Position washer (see Special Tools in this chapter) on bearing to allow pressing on both inner and outer bearing races simultaneously.

B. Use washer and bearing/outer seal tool (see Special Tools in this chapter) with a soft face hammer to fully seat bearing (Fig. 42). After bearing installation, make sure that shaft freely rotates and that no binding is detected. If necessary, lightly tap bearing and/or shaft ends to align shaft and bearings. Remove washer from roller.

C. Apply a small amount of grease around the lip of both outer seals.

D. Carefully install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (see Special Tools in this chapter) and soft face hammer to lightly seat seal (Fig. 43). Make sure that shaft and bearings still freely rotate after seal installation.

E. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that shaft and bearings still freely rotate.

IMPORTANT: Make sure that all grease is removed from shaft threads to prevent bearing lock nut loosening.

5. Thoroughly clean threads on both ends of roller shaft.

NOTE: If original bearing lock nut(s) are being used, apply Loctite #242 (or equivalent) to threads of lock nut(s).

6. Install bearing lock nut onto each end of the roller shaft. Make sure that outer seals are not damaged during nut installation. Torque lock nuts from **50 to 60 ft-lb (68 to 81 N-m)**.

7. If set screw was removed from either end of roller shaft, apply Loctite #242 (or equivalent) to threads of removed set screw and install into roller shaft. Tighten set screw until it bottoms in shaft and is recessed in shaft.

IMPORTANT: When roller assembly is installed to cutting deck, make sure that grease groove in each roller mount aligns with the grease hole in each end of roller shaft.

NOTE: After roller is installed to cutting deck, lubricate roller grease fittings, rotate roller to properly distribute grease in bearings and clean excess grease from roller ends. A properly assembled roller should rotate with less than 5 in-lbs (0.68 N-m) resistance.

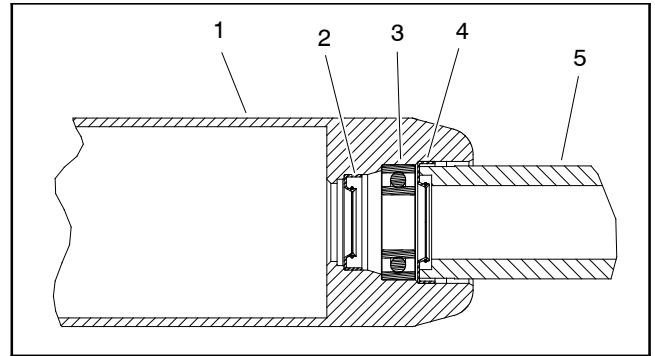


Figure 41

- | | |
|----------------|----------------------------|
| 1. Roller tube | 4. Outer seal |
| 2. Inner seal | 5. Bearing/outer seal tool |
| 3. Bearing | |

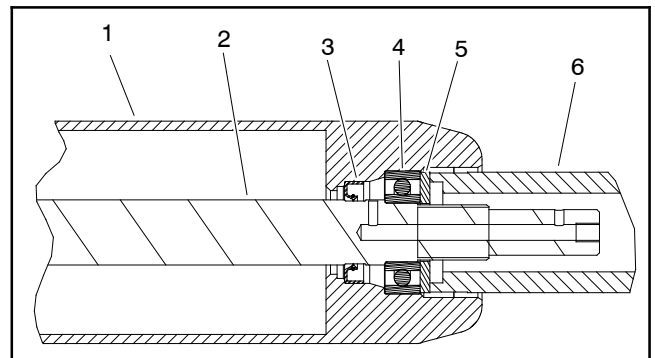


Figure 42

- | | |
|-----------------|----------------------------|
| 1. Roller tube | 4. Bearing |
| 2. Roller shaft | 5. Washer |
| 3. Inner seal | 6. Bearing/outer seal tool |

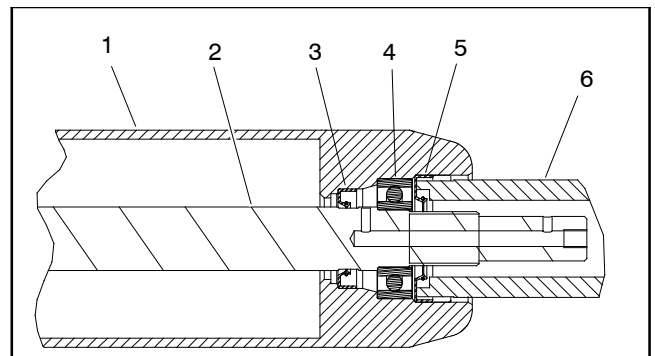


Figure 43

- | | |
|-----------------|----------------------------|
| 1. Roller tube | 4. Bearing |
| 2. Roller shaft | 5. Outer seal |
| 3. Inner seal | 6. Bearing/outer seal tool |

Cutting Units

Rear Roller Brush (Optional)

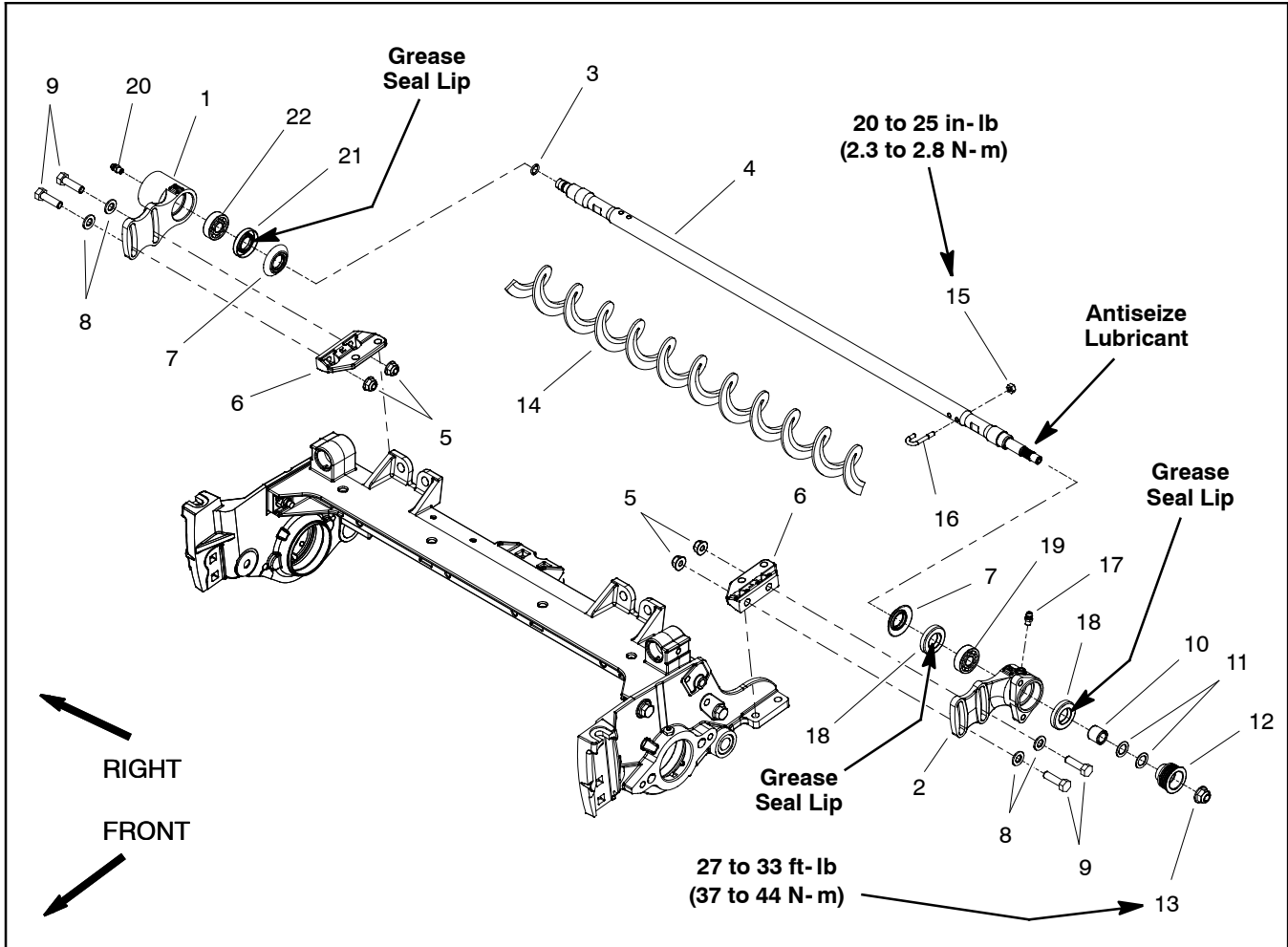


Figure 44

- | | | |
|--------------------------------------|--|---------------------|
| 1. Brush bearing housing (non-drive) | 9. Cap screw (4 used) | 16. J-bolt (2 used) |
| 2. Brush bearing housing (drive) | 10. Spacer | 17. Grease fitting |
| 3. O-ring | 11. Flat washer (for pulley alignment) | 18. Grease seal |
| 4. Roller brush shaft | 12. Driven pulley | 19. Ball bearing |
| 5. Flange nut (4 used) | 13. Flange nut | 20. Grease fitting |
| 6. Mounting bracket (2 used) | 14. Roller brush | 21. Grease seal |
| 7. Excluder seal (2 used) | 15. Lock nut | 22. Ball bearing |
| 8. Flat washer (4 used) | | |

NOTE: Drive components for the rear roller brush are located on the opposite side of the cutting unit from the cutting reel motor. Figure 44 shows components used when the brush drive is on the left side of the cutting unit.

NOTE: The Installation Instructions for the rear roller brush kit has detailed information regarding assembly and adjustment. Use those Instructions along with this Service Manual when servicing the rear roller brush.

Disassembly (Fig. 44)

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. To prevent unexpected reel motor operation, disconnect motors from the electrical power supply by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).

3. To remove roller brush from brush shaft:

A. Remove the non-drive brush bearing housing (item 1) from cutting unit.

B. Slide excluder seal from roller brush shaft.

C. Remove lock nut and J-bolt from both ends of the brush.

D. While rotating brush, slide brush from the shaft.

4. Disassemble roller brush components as necessary using Figures 44 as a guide. If drive brush bearing housing (item 2) or driven pulley (item 12) need to be removed, brush cover and drive belt removal will be necessary (see Rear Roller Brush Drive System in this section).

Assembly (Fig. 44)

1. If seals or bearings were removed from brush bearing housings, install new components noting proper orientation as shown in Figure 46.

A. Pack bearings with high temp Mobil XHP-222 grease (or equivalent) before installation.

B. Press bearing into bearing housing so that bearing contacts shoulder in housing bore.

C. Install grease seals so that seal lips are positioned toward the brush location as shown in Fig. 46. Press seals into housing so that seal contacts bore shoulder.

2. If roller brush was removed from roller shaft, slide brush onto shaft while rotating brush. Secure brush to shaft with two (2) J- bolts and lock nuts. Make sure that the J- bolts are installed with the threaded portion on the outside of the brush (Fig. 45). Torque lock nuts from **20 to 25 in-lb (2.3 to 2.8 N-m)**.

3. Assemble roller brush components using Figure 44 as a guide noting the following items:

A. Apply coating of grease to lips of grease seals in brush bearing housing before inserting brush shaft into housing.

B. If driven pulley (item 12) was removed from roller brush shaft, apply antiseize lubricant to splines of pulley bore and slide pulley onto shaft. Install and tighten flange nut until pulley is seated onto shaft and then torque flange nut from **27 to 33 ft-lb (37 to 44 N-m)**. Use a ½ wrench on roller brush shaft flats to prevent shaft from rotating when tightening nut.

C. Position excluder seals on brush shaft so that seals just touch bearing housings.

D. If driven pulley (item 12) was removed, check and adjust alignment of drive and driven pulleys (see Rear Roller Brush Drive System in this section).

4. Check that brush is parallel to rear roller with 0.060" (1.5 mm) clearance to light contact with rear roller (Fig. 47). If contact is incorrect, brush operation will be adversely affected.

5. Lubricate grease fittings on brush housings until grease purges past inboard seals. Wipe excess grease from seals and fittings.

6. Once all rear roller brush service is completed, plug the 48 VDC battery disconnect back in before operating the machine.

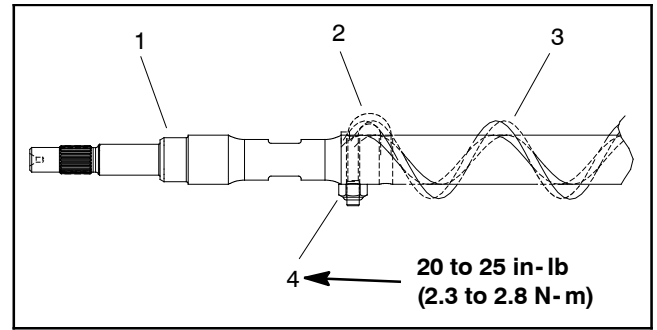


Figure 45

- | | |
|-----------------------|-----------------|
| 1. Roller brush shaft | 3. Roller brush |
| 2. J-bolt | 4. Lock nut |

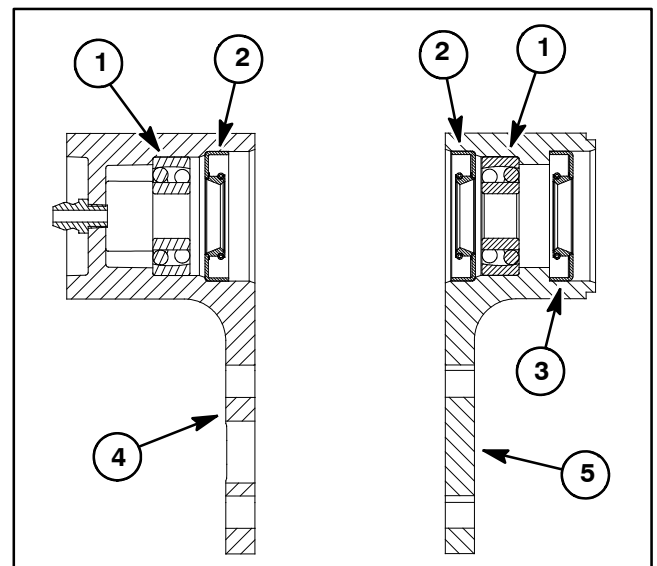


Figure 46

- | | |
|----------------------|-------------------------|
| 1. Bearing | 4. Housing (non-driven) |
| 2. Inner grease seal | 5. Housing (driven) |
| 3. Outer grease seal | |

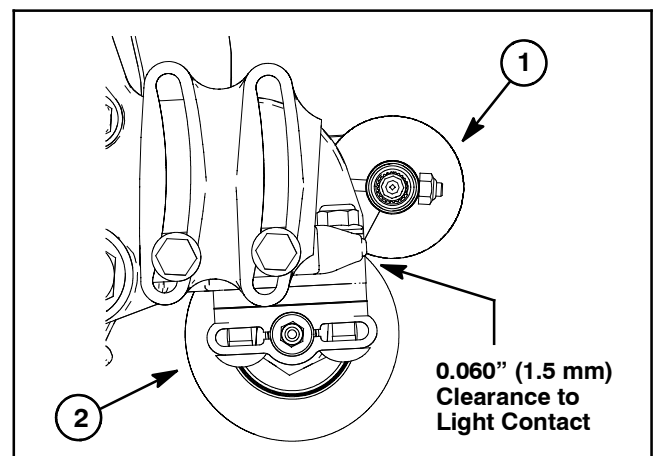


Figure 47

- | | |
|----------------------|----------------|
| 1. Rear roller brush | 2. Rear roller |
|----------------------|----------------|

Cutting Units

Rear Roller Brush Drive System (Optional)

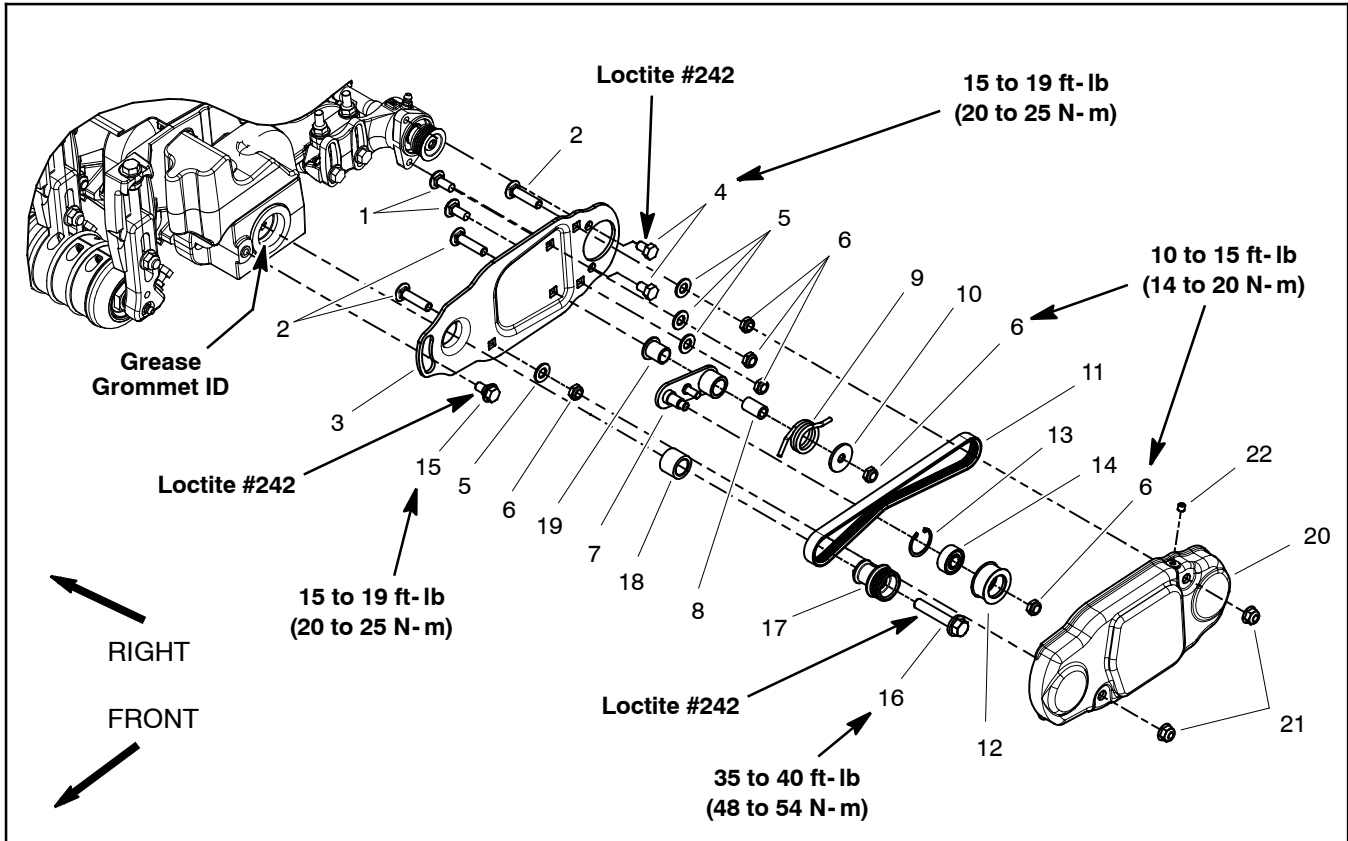


Figure 48

- | | | |
|----------------------------|--------------------|-----------------------------------|
| 1. Carriage screw (2 used) | 9. Idler spring | 16. Flange head screw |
| 2. Carriage screw (3 used) | 10. Pivot washer | 17. Drive pulley |
| 3. Brush plate | 11. Drive belt | 18. Spacer |
| 4. Cap screw (2 used) | 12. Idler pulley | 19. Flange bushing |
| 5. Flat washer (4 used) | 13. Retaining ring | 20. Cover |
| 6. Lock nut (6 used) | 14. Bearing | 21. Flange nut (2 used) |
| 7. Idler arm | 15. Shoulder screw | 22. Set screw (top of cover only) |
| 8. Idler spacer | | |

NOTE: Drive components for the rear roller brush are located on the opposite side of the cutting unit from the cutting reel motor. Figure 44 shows components used when the brush drive is on the left side of the cutting unit.

NOTE: The Installation Instructions for the rear roller brush kit has detailed information regarding assembly and adjustment. Use those Instructions along with this Service Manual when servicing the rear roller brush.

Disassembly (Fig. 48)

1. Position machine on a clean and level surface, lower cutting units, stop engine, engage parking brake and remove key from the ignition switch.

2. To prevent unexpected reel motor operation, disconnect motors from the electrical power supply by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).

3. Remove cover (item 20) to access rear roller brush drive components.

4. Remove roller brush drive components as necessary using Figure 48 as a guide.

5. Remove roller brush drive shaft if needed (Fig. 49):

A. Remove socket head screws that secure drive housing to cutting unit side plate and remove housing from cutting unit.

IMPORTANT: If rear roller brush drive is on left side of cutting unit, drive shaft has left hand threads and can be identified by a groove on the flange. If the rear roller brush drive is on right side of cutting unit, drive shaft has right hand threads and does not have a groove on the flange (Fig. 50).

B. Loosen and remove drive shaft from cutting reel.

Assembly (Fig. 48)

1. Install drive shaft if it was removed (Fig. 49):

IMPORTANT: If rear roller brush drive is on left side of cutting unit, drive shaft has left hand threads and can be identified by a groove on the flange. If the rear roller brush drive is on right side of cutting unit, drive shaft has right hand threads and does not have a groove on the flange (Fig. 50).

A. Apply Loctite #242 (or equivalent) to threads of drive shaft. Thread drive shaft into cutting reel and torque from **85 to 95 ft-lb (115 to 128 N-m)**.

B. Make sure that O-ring is placed on inner flange of drive housing.

C. Position housing to cutting unit side plate and secure to cutting unit with two (2) socket head screws.

D. Make sure that grommet groove is correctly seated on flange in drive housing bore.

2. Assemble roller brush components using Figure 48 as a guide.

A. During assembly, apply Loctite #242 (or equivalent) to threads of fasteners and torque fasteners as shown in Figure 48.

B. Apply a light coating of grease to inner diameter of the grommet in drive bearing housing before installing brush plate.

C. Brush plate should be installed so that idler pulley assembly is toward the bottom of the plate. Also, the shoulder bolt (item 15) should not clamp the brush plate to the drive housing during assembly.

D. When installing drive pulley (item 17), make sure that tabs on pulley engage slot in drive shaft.

E. Idler arm (item 7) should be free to rotate after assembly to brush plate. Make sure that idler spring is installed so that it can rotate the idler arm and pulley and apply tension to the drive belt.

F. After drive belt installation, make sure that the ribs on the belt are properly seated in the grooves of both the drive and driven pulleys and that the belt is in the center of the idler pulley.

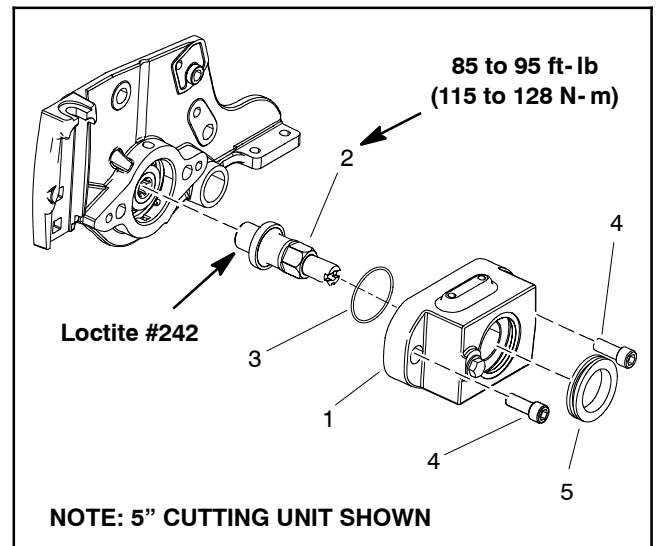


Figure 49

- | | |
|------------------|----------------------|
| 1. Drive housing | 4. Socket head screw |
| 2. Drive shaft | 5. Grommet |
| 3. O-ring | |

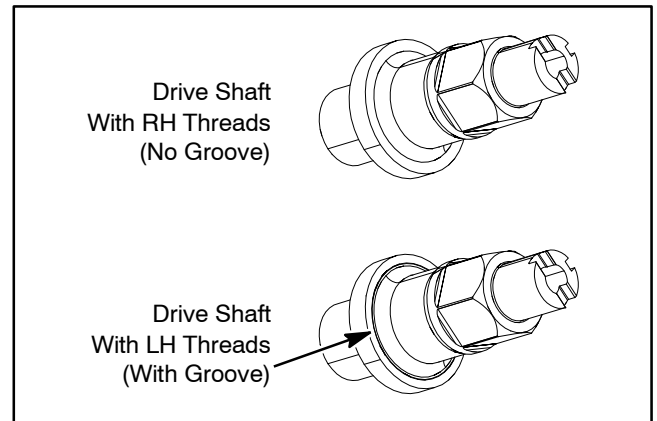


Figure 50

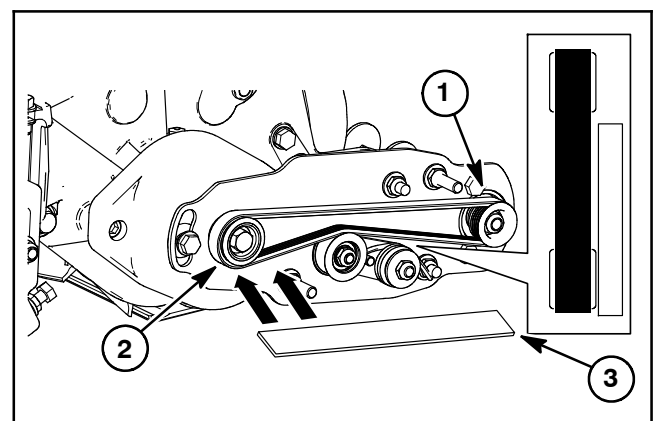


Figure 51

- | | |
|------------------|------------------|
| 1. Driven pulley | 3. Straight edge |
| 2. Drive pulley | |

3. After assembly (including drive belt installation), check alignment of pulleys with a straight edge placed along the outer face of the drive pulley (Fig. 51).

A. The outer faces of the drive and driven pulleys (not the idler pulley) should be in-line within 0.030" (0.76 mm).

B. If necessary to align pulleys, remove driven pulley from brush shaft and add or remove flat washer(s) until drive and driven pulleys are correctly aligned (Fig. 52).

C. If driven pulley was removed from roller brush shaft, apply antiseize lubricant to splines of pulley bore and slide pulley onto shaft. Install and tighten flange nut until pulley is seated onto shaft and then torque flange nut from **27 to 33 ft-lb (37 to 44 N-m)**. Use a ½ wrench on roller brush shaft flats to prevent shaft from rotating when tightening nut.

4. Check that brush is parallel to rear roller with 0.060" (1.5 mm) clearance to light contact with rear roller. If contact is incorrect, brush operation will be adversely affected.

5. Install cover (item 20). There should not be a set screw installed in the bottom of the cover.

6. Lubricate grease fittings on brush housings until grease purges past inboard seals. Wipe excess grease from seals and fittings.

7. Once all rear roller brush service is completed, plug the 48 VDC battery disconnect back in before operating the machine.

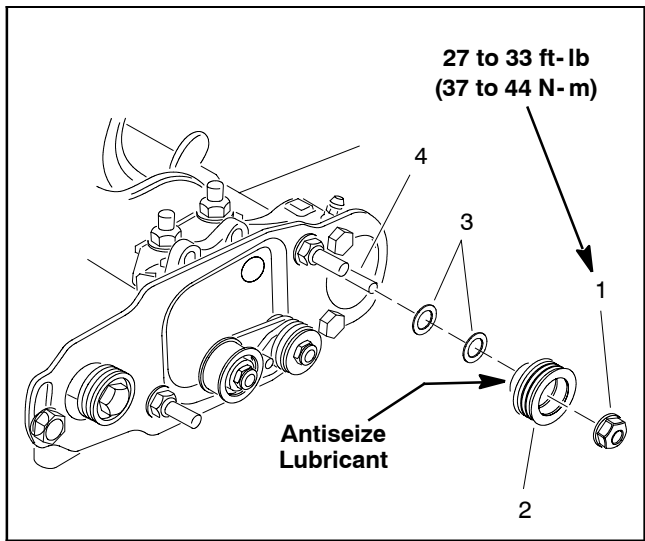


Figure 52

- | | |
|------------------|-----------------------|
| 1. Flange nut | 3. Flat washer |
| 2. Driven pulley | 4. Roller brush shaft |



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General Information

Groomer Kit Installation Instructions

The groomer kit installation instructions provides information regarding the installation, set-up and operation of the optional groomer on your Reelmaster machine. Refer to this publication for additional information when servicing the groomer.

48 VDC Battery Disconnect



CAUTION

Before installing, removing or servicing components in the 48 VDC system (e.g. cutting unit motors, motor/generator), separate the 48 VDC battery disconnect. This will prevent unexpected operation of 48 VDC system components.

The 48 VDC battery disconnect is attached to the right frame rail under the operator seat (Fig. 1). Unplug the disconnect to make sure that 48 VDC components do not operate unexpectedly. Apply dielectric grease to the contact surfaces of the battery disconnect and plug the battery disconnect back in after service to the 48 VDC system is completed.

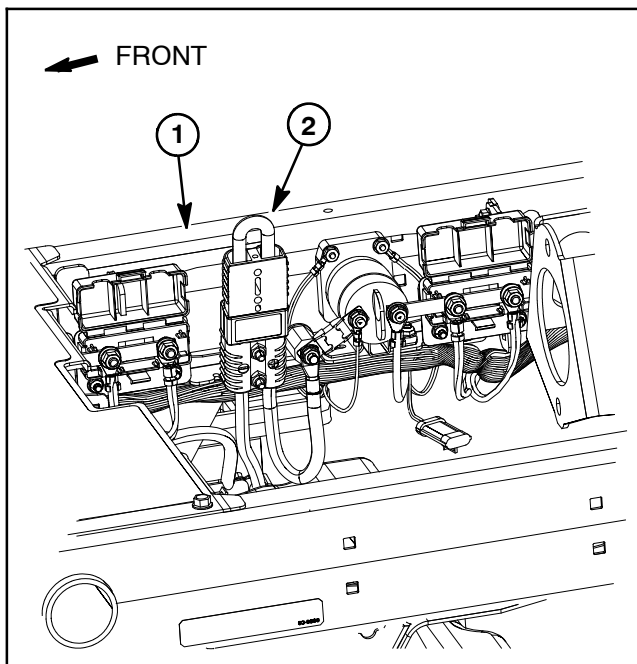


Figure 1

- 1. RH frame rail
- 2. 48V battery disconnect

Special Tools

Order Special Tools from your Toro Distributor. Some tools may have been supplied with your machine or are available as Toro parts.

Spline Insert Tool

Toro Part Number: **TOR4112** (8 tooth for 5 inch reels)
TOR4074 (9 tooth for 7 inch reels)

Use spline insert tool for rotating cutting reel when motor is removed. Also use this tool for installation of threaded inserts into cutting reel shaft.

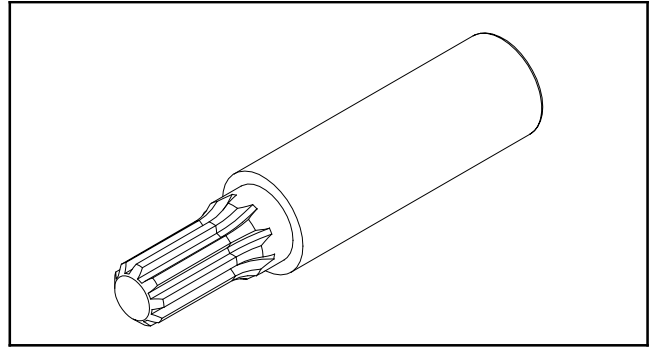


Figure 2

Pulley Alignment Tool

Toro Part Number: **114-5446**

Use pulley alignment tool to verify alignment of groomer drive and driven pulleys.

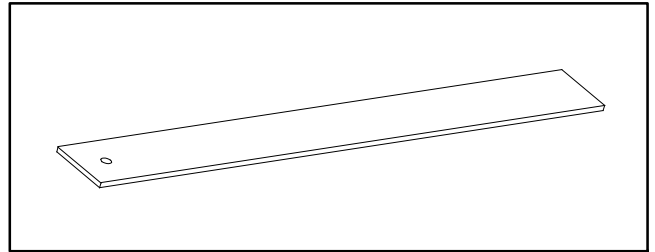


Figure 3

Gauge Bar Assembly

Toro Part Number: **108-6715**

Use gauge bar to verify height-of-cut adjustment. Also used for adjustment of optional groomer.

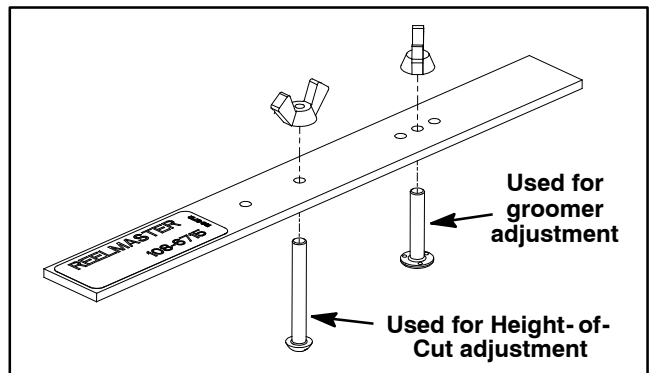


Figure 4

Grooming Performance

There are a number of factors that can affect the performance of grooming. These factors vary for different golf courses and from fairway to fairway. It is important to inspect the turf frequently and vary the grooming practice with turf needs.

IMPORTANT: Improper or overaggressive use of the groomer (e.g. too deep or too frequent grooming) may cause unnecessary stress on the turf leading to severe turf damage. Use the groomer carefully. READ AND UNDERSTAND THE GROOMER OPERATION INSTRUCTIONS BEFORE OPERATING OR TESTING GROOMER PERFORMANCE.

It is important to remember that factors affecting quality of cut also affect grooming performance.

Variables That Affect the Use and Performance of Groomers:

1. The growing season and weather conditions.
2. General turf conditions.
3. The frequency of grooming/cutting - number of cuttings per week and how many passes per cutting.
4. The height-of-cut.
5. The grooming depth.
6. The type of grass.
7. The amount of time that a groomer reel has been in use on a particular turf area.
8. The amount of traffic on the turf.
9. The overall turf management program - irrigation, fertilizing, weed control, coring, overseeding, sand dressing, disease control and pest control.
10. Stress periods for turf - high temperatures, high humidity, unusually high traffic.

Troubleshooting

Groomer Reel Mechanical Problems

Problem	Possible Causes	Correction
<p>No rotation of the groomer reel.</p>	<p>The groomer drive belt needs to be adjusted.</p> <p>Failed groomer idler bearing(s) in groomer side plate(s).</p> <p>Broken or damaged idler spring.</p> <p>The groomer drive belt is worn, broken or damaged.</p> <p>Grooming depth is too deep.</p> <p>Groomer drive shaft is loose in cutting reel.</p> <p>Groomer drive pulley square key is damaged or missing.</p> <p>Flange head screw that secures groomer drive pulley is loose or damaged.</p>	<p>Adjust groomer drive belt.</p> <p>Replace faulty bearing(s).</p> <p>Replace spring.</p> <p>If the drive belt slips, it probably is out of adjustment or worn.</p> <p>Repair or replace drive belt if necessary. A broken or worn belt could be the result of improper belt routing or seized bearings in groomer assembly.</p> <p>Change grooming depth.</p> <p>Correctly tighten groomer drive shaft. Replace drive shaft if threads are faulty.</p> <p>Replace missing or damaged square key.</p> <p>Correctly tighten groomer drive pulley with existing flange head screw. Replace screw if threads are faulty.</p>
<p>The turf is damaged or has uneven grooming.</p>	<p>The groomer reel blades are bent, damaged or missing.</p> <p>The groomer reel shaft is bent or damaged.</p> <p>Grooming depth is not equal on both ends of groomer reel.</p>	<p>Repair or replace blades if necessary.</p> <p>Replace groomer reel shaft.</p> <p>Adjust depth if necessary. Also, check and adjust cutting unit set up (level bedknife to reel, level rear roller to reel, set height-of-cut, etc.).</p>

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Adjustments



CAUTION

Never work on the groomer with the engine running. Always stop the engine, remove the key from the ignition switch and wait for all machine movement to stop before working on the groomer.

Also, before installing, removing or working on the cutting units, disconnect the cutting units from the electrical power supply by separating the cutting unit power disconnect connector (see 48 VDC Battery Disconnect in the General Information section of this chapter).

Groomer Height/Depth Adjustment

NOTE: Grooming is performed above the soil level. When adjusting groomer height/depth, groomer blades should never penetrate the soil.

1. Park machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the ignition switch.

2. To prevent unexpected reel motor operation, disconnect motors from the electrical power supply by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).

3. Make sure rollers are clean and cutting unit is set to the desired height-of-cut (see Cutting Unit Operator's Manual).

4. Place the groomer reel in the grooming (lowered) position by rotating the quick-up levers toward the front of the cutting unit (Fig. 5).

NOTE: Improper or over-aggressive use of the groomer (e.g. too deep or too frequent grooming) may cause unnecessary stress on the turf leading to severe turf damage. Use the groomer cautiously.

NOTE: Use the gauge bar assembly (see Special Tools in this chapter) to determine groomer height.

5. Measure the distance from the lowest tip of the groomer blade to the working surface. Turn groomer height adjuster to raise or lower the groomer blade tip to the desired height (Fig. 5).

6. Repeat step 5 on the opposite end of the groomer. Then, recheck setting on the first side of groomer. Height setting on both ends of groomer should be identical.

7. Plug the 48 VDC battery disconnect back in before operating the machine.

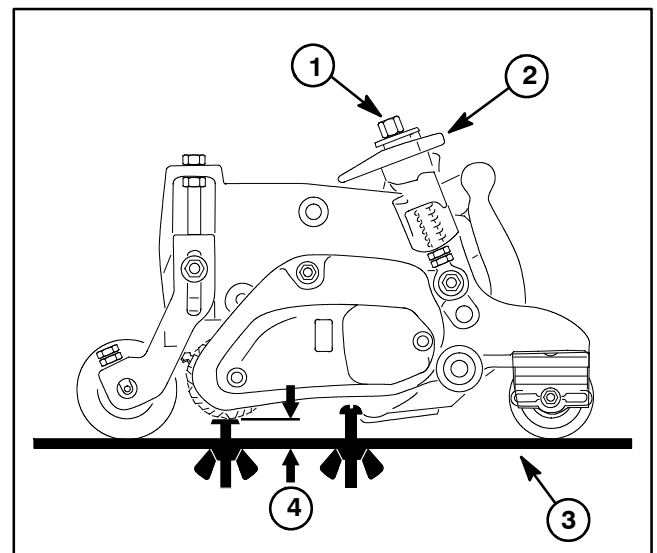


Figure 5

- | | |
|----------------------------|-----------------------|
| 1. Groomer height adjuster | 3. Gauge bar assembly |
| 2. Quick-up lever | 4. Groomer height |

Service and Repairs



CAUTION

Never work on the groomer with the engine running. Always stop the engine, remove the key from the ignition switch and wait for all machine movement to stop before working on the groomer.

Also, before installing, removing or working on the cutting units, disconnect the electrical power supply by separating the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).

Groomer Drive Assembly

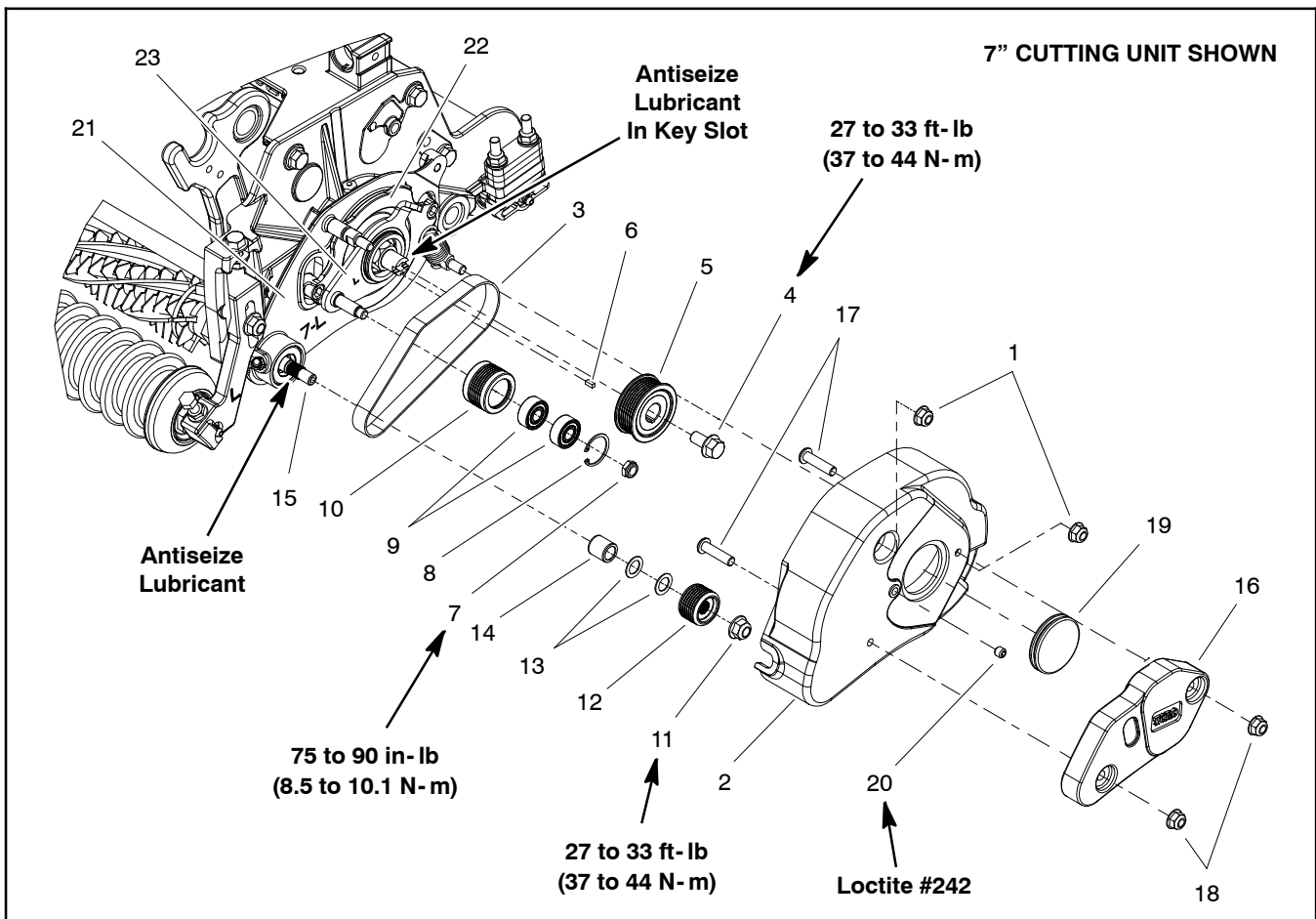


Figure 6

- | | | |
|------------------------|-----------------------------------|-------------------------|
| 1. Flange nut (2 used) | 9. Ball bearing (2 used) | 17. Screw (2 used) |
| 2. Groomer cover | 10. Idler pulley | 18. Flange nut (2 used) |
| 3. Groomer drive belt | 11. Flange nut | 19. Grommet |
| 4. Flange head screw | 12. Drive pulley | 20. Set screw |
| 5. Drive pulley | 13. Washer (for pulley alignment) | 21. Groomer plate |
| 6. Square key | 14. Spacer | 22. Pivot hub |
| 7. Lock nut | 15. Groomer drive shaft | 23. Idler plate |
| 8. Retaining ring | 16. Groomer weight | |

NOTE: The groomer drive is located on the opposite side of the cutting unit from the cutting reel motor. Figure 6 shows components used when the groomer drive is on the left side of the cutting unit.

Disassembly (Fig. 6)

1. Park machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the ignition switch.

2. To prevent unexpected reel motor operation, disconnect motors from the electrical power supply by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).

NOTE: If cutting unit is equipped with powered rear roller brush, removal of roller brush components will be necessary to replace groomer drive belt (see Rear Roller Brush (Optional) in the Service and Repairs section of Chapter 7 - Cutting Units).

NOTE: When removing groomer cover, groomer weight does not have to be removed from cover.

3. Remove two (2) flange nuts that secure groomer cover, then remove cover.

4. Remove groomer drive belt tension by pivoting idler plate and pulley using a wrench on pulley nut. Slip groomer drive belt off pulleys. Carefully release idler plate and pulley.

5. As needed, remove drive pulley (item 5), driven pulley (item 12) and idler pulley (item 10) using Figure 6 as a guide.

NOTE: See Groomer Plate Assembly in this section for information on removing and installing groomer plate (item 21), pivot hub (item 22) or idler plate (item 23).

Assembly (Fig. 6)

1. If idler pulley (item 10) was removed, make sure that bearings are in good condition before installing pulley. Slide pulley assembly onto idler plate shaft and secure with flange nut. Torque flange nut from **75 to 90 in-lb (8.5 to 10.1 N-m)**.

NOTE: To prevent groomer shaft from turning when installing driven pulley, use wrench on groomer shaft flats.

2. If driven pulley (item 10) was removed, make sure that spacer and washer(s) are on groomer shaft. Apply antiseize lubricant to splines of drive pulley, slide pulley onto groomer shaft and secure with flange nut. Torque flange nut from **27 to 33 ft-lb (37 to 44 N-m)**.

NOTE: To prevent cutting reel from turning when installing drive pulley, block cutting reel with piece of wood.

3. If drive pulley (item 5) was removed, apply antiseize lubricant to key slot in shaft. Place square key into shaft slot. Slide drive pulley onto shaft and secure with flange head screw. Torque screw from **27 to 33 ft-lb (37 to 44 N-m)**.

4. Check pulley alignment by laying a straight edge along the outer face of the drive pulley (Fig. 7). Drive and driven pulleys should be in line within 0.030" (0.76 mm). If necessary, align pulleys by removing driven pulley and installing or removing washer(s) (item 13 in Figure 6) between pulley and pulley spacer. Do not use idler pulley to check pulley alignment.

5. Install drive belt to drive pulley, idler pulley and driven pulley observing correct belt routing (Fig. 7). Make sure that groomer drive belt is above idler pulley after belt installation and also that the ribs on drive belt are seated in grooves in each pulley.

6. Install groomer cover and secure with two (2) flange nuts.

7. Plug the 48 VDC battery disconnect back in before operating the machine.

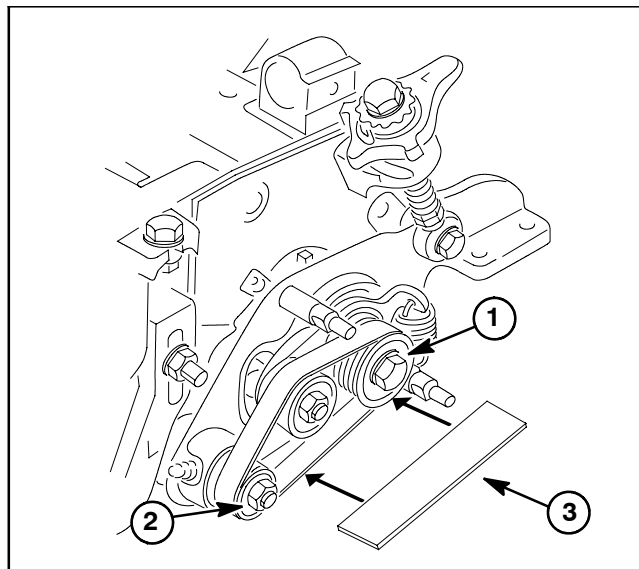


Figure 7

- 1. Drive pulley
- 2. Driven pulley
- 3. Straight edge

Groomer Reel and Groomer Plate Assembly

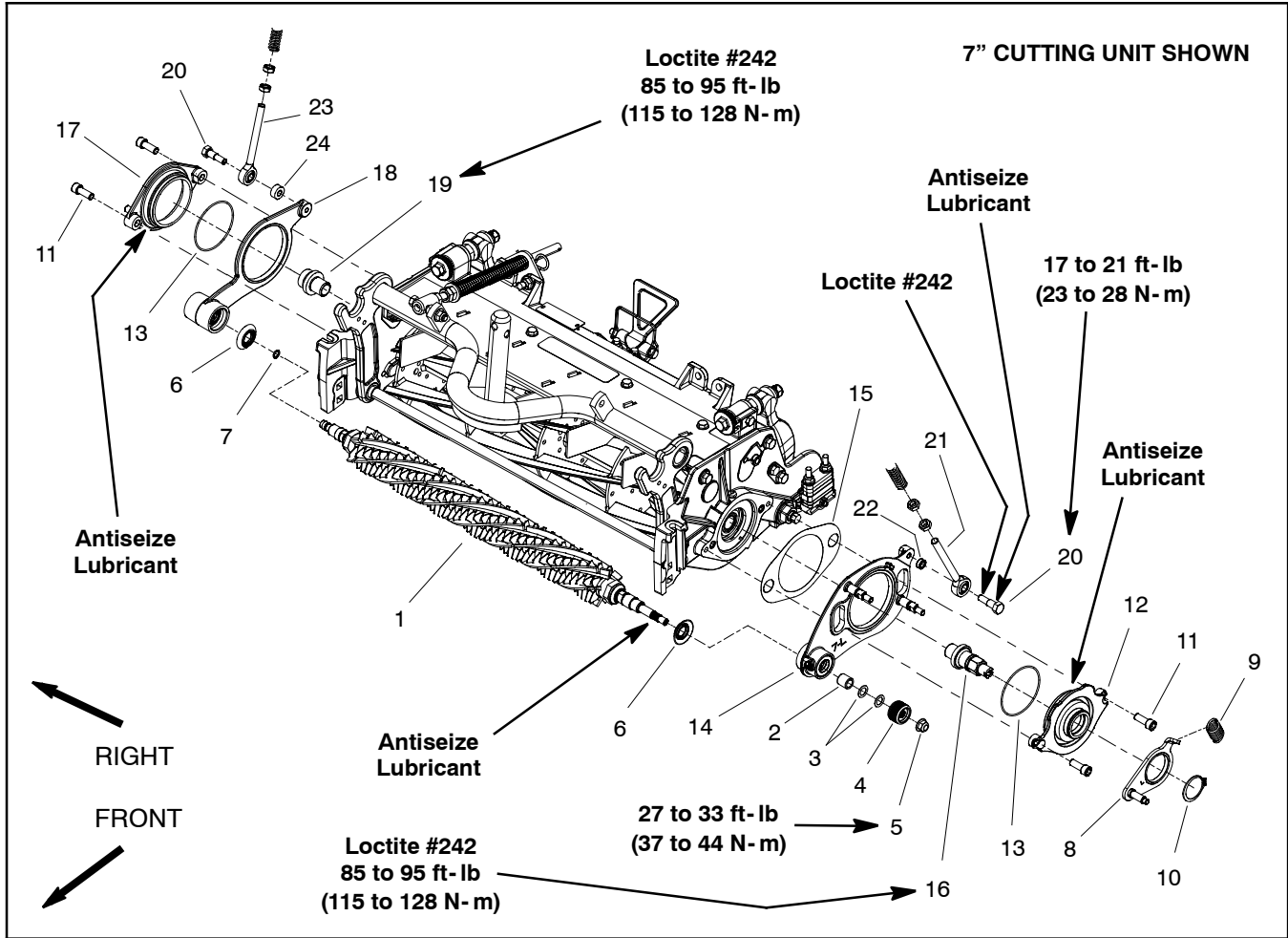


Figure 8

- | | | |
|----------------------------------|--|------------------------------------|
| 1. Groomer reel | 9. Extension spring | 17. Pivot hub (non-drive side) |
| 2. Pulley spacer | 10. Retaining ring | 18. Groomer plate (non-drive side) |
| 3. Washer (for pulley alignment) | 11. Socket head screw (2 used per hub) | 19. Reel threaded insert |
| 4. Driven pulley | 12. Pivot hub (drive side) | 20. Shoulder bolt |
| 5. Flange nut | 13. O-ring (1 used per hub) | 21. LH ball joint rod |
| 6. Excluder seal (2 used) | 14. Groomer plate (drive side) | 22. Spacer |
| 7. O-ring | 15. Groomer shim | 23. RH ball joint rod |
| 8. Idler plate | 16. Groomer drive shaft | 24. Spacer |

NOTE: The groomer reel drive is located on the opposite side of the cutting unit from the cutting reel motor. Figure 8 shows components used when the groomer reel drive is on the left side of the cutting unit.

Removal (Fig. 8)

1. Park machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the ignition switch. Remove cutting unit from machine.

NOTE: If cutting unit is equipped with powered rear roller brush, removal of roller brush components will be necessary to service groomer plate assemblies (see Rear Roller Brush (Optional) in the Service and Repairs section of Chapter 7 - Cutting Units).

2. To remove groomer plate (item 14) from groomer drive side of cutting unit:

A. Remove groomer belt cover, groomer drive belt, drive pulley and driven pulley from cutting unit (see Groomer Assembly in this section).

B. Slide washer(s) (item 3) and pulley spacer (item 2) from groomer shaft.

C. Remove shoulder bolt (item 20) that secures quick-up ball joint rod to drive side groomer plate. Locate and retrieve spacer from between ball joint rod and groomer plate.

D. Disconnect idler extension spring (item 9) from stud on groomer plate.

E. Remove two (2) socket head screws (item 11) that secure pivot hub to cutting unit side plate.

F. Remove pivot hub with attached idler plate assembly from cutting unit.

G. Support groomer shaft to prevent it from falling. Carefully slide drive side groomer plate from groomer shaft and cutting unit. Remove groomer shim (item 15).

3. Carefully pull the groomer reel from the non-drive side groomer plate assembly.

4. To remove groomer plate (item 18) from groomer non-drive side of cutting unit:

A. Remove shoulder bolt (item 20) that secures quick-up ball joint rod to non-drive side groomer plate. Locate and retrieve spacer from between ball joint rod and groomer plate.

B. Remove two (2) socket head screws (item 11) that secure pivot hub to cutting unit side plate.

C. Remove pivot hub from cutting unit.

D. Support groomer shaft to prevent it from falling. Carefully slide non-drive side groomer plate from groomer shaft and cutting unit.

5. Inspect seals, bearings and bushings in groomer plates. Remove and discard damaged components.

NOTE: See Groomer Reel Service in this section for information about groomer reel disassembly and assembly.

Installation (Fig. 8)

1. If seals, bearings or bushing was removed from either of the groomer plates, install new components noting proper orientation as shown in Figures 9, 10 and 11.

A. Press bushing into groomer plate until the bushing contacts the shoulder in the groomer plate bore.

B. Pack bearings with grease before installation.

C. Press bearings into groomer plate so that bearings contact shoulder in groomer plate bore.

D. Install grease seals so that seal lips are positioned toward the groomer blade location. Seals should be flush with surface of groomer plate.

E. If groomer studs were removed from drive side groomer plate and studs are being reinstalled, apply Loctite #242 (or equivalent) to threads of studs. New studs have patchlock on threads. Install studs into groomer plate and torque from **14 to 18 ft-lb (19 to 24 N-m)**.

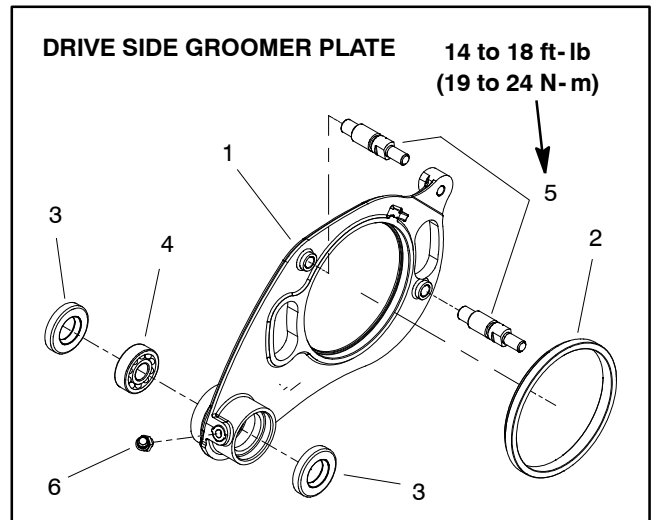


Figure 9

- | | |
|------------------|-------------------|
| 1. Groomer plate | 4. Bearing |
| 2. Bushing | 5. Groomer stud |
| 3. Seal | 6. Grease fitting |

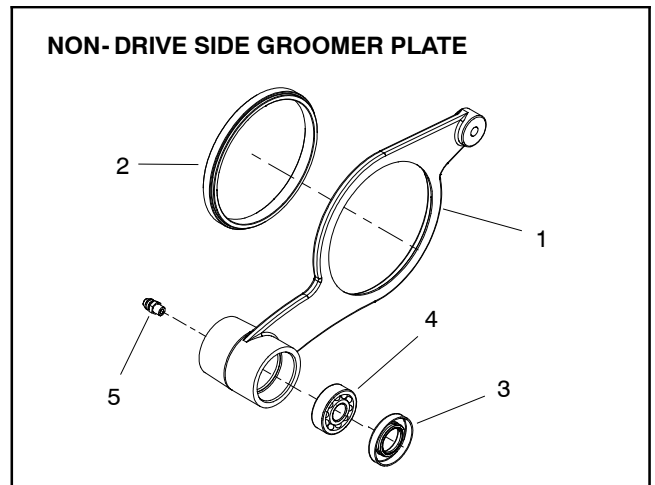


Figure 10

- | | |
|------------------|-------------------|
| 1. Groomer plate | 4. Bearing |
| 2. Bushing | 5. Grease fitting |
| 3. Seal | |

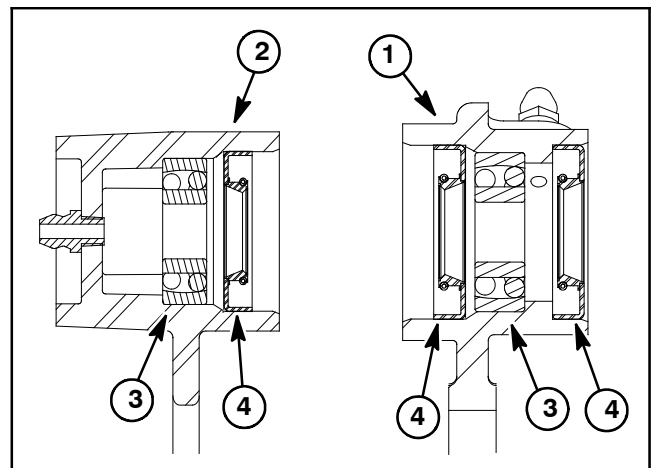


Figure 11

- | | |
|-----------------------------|----------------|
| 1. Drive side groomer plate | 3. Bearing |
| 2. Non-drive groomer plate | 4. Grease seal |

2. If removed, install groomer plate (item 18) to groomer non-drive side of cutting unit:

A. Position non-drive side groomer plate to cutting unit side plate.

B. Slide O-ring onto pivot hub and then apply anti-seize lubricant onto pivot hub flange. Position pivot hub to groomer plate and cutting unit.

C. Secure pivot hub to cutting unit side plate with two (2) socket head screws (item 11). Make sure that groomer plate rotates freely after installation.

D. Apply anti-seize lubricant to shoulder area of shoulder bolt that secures quick-up ball joint rod to non-drive side groomer plate and apply Loctite #242 (or equivalent) to threads of shoulder bolt. Position spacer between ball joint rod and groomer plate. Install shoulder bolt and torque from **17 to 21 ft-lb (23 to 28 N-m)**.

3. Make sure that O-ring (item 7) is on groomer reel shaft and is lightly greased. Also, apply a light coat of grease to lip of seal in installed groomer plate.

4. Make sure that excluder seals (item 6) and lightly greased O-ring (item 7) are positioned on groomer shaft. The excluder seal lips should be toward the end of the groomer shaft. Apply a film of grease onto excluder seal lips.

5. Carefully slide the groomer reel into the non-drive side groomer plate assembly taking care to not damage seals in groomer plate assembly.

6. Carefully install groomer plate (item 14) to groomer drive side of cutting unit:

A. Apply a light coat of grease to lips of seals in groomer plate.

B. Position groomer shim to cutting unit side plate. Carefully position drive side groomer plate onto groomer shaft and slide to cutting unit.

C. Slide O-ring onto pivot hub and then apply anti-seize lubricant onto pivot hub flange. Position pivot hub with attached idler plate assembly to cutting unit side plate and secure with two (2) socket head screws (item 11). Make sure that groomer shim has not shifted and that groomer plate rotates freely after installation.

D. Connect extension spring (item 9) to stud on groomer plate. Make sure that spring is in the stud groove and that spring hook is positioned toward the drive pulley location.

E. Apply anti-seize lubricant to shoulder area of shoulder bolt that secures quick-up ball joint rod to drive side groomer plate and apply Loctite #242 (or equivalent) to threads of shoulder bolt. Position spacer between ball joint rod and groomer plate. Install shoulder bolt and torque from **17 to 21 ft-lb (23 to 28 N-m)**.

F. Slide pulley spacer (item 2) and washer(s) (item 3) onto groomer shaft.

G. Install drive pulley, driven pulley and groomer drive belt to cutting unit (see Groomer Assembly in this section). Make sure that fasteners are correctly torqued. Also, make sure that drive and driven pulley alignment is checked and adjusted if necessary. Install groomer belt cover.

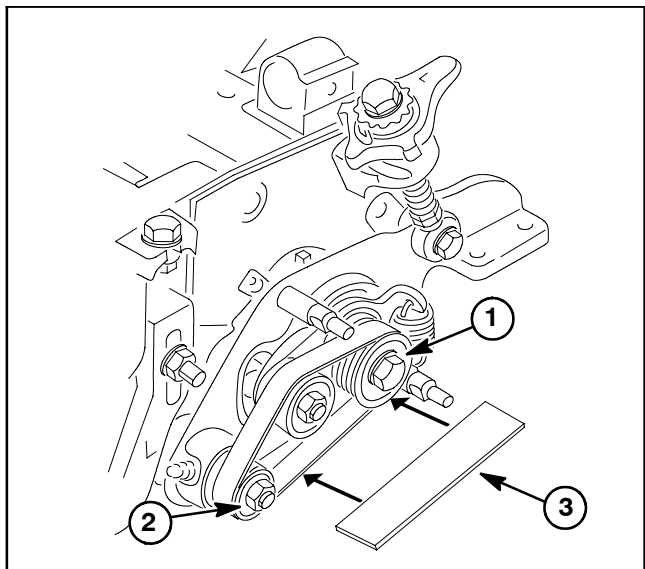


Figure 12

- 1. Drive pulley
- 2. Driven pulley
- 3. Straight edge

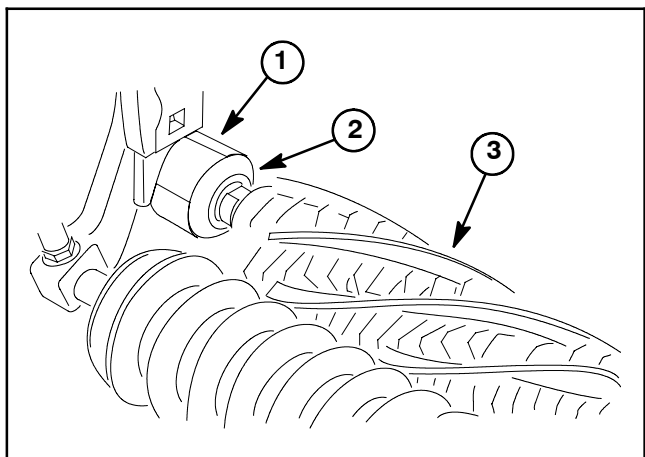


Figure 13

- 1. Groomer plate
- 2. Excluder seal
- 3. Groomer reel

7. Check that excluder seals just touch groomer plate assembly (Fig. 13). Reposition excluder seals on groomer shaft if needed. Excluder seal ID should be located on groomer shaft surface that is recessed slightly.

8. Check groomer reel height and mower height-of-cut settings. Adjust as needed.

9. Lubricate groomer bearings.

10. Install cutting unit back on machine.

NOTE: After greasing groomer bearings, operate groomer for thirty (30) seconds, stop machine and wipe excess grease from groomer shaft and seals.

Groomer Reel Service

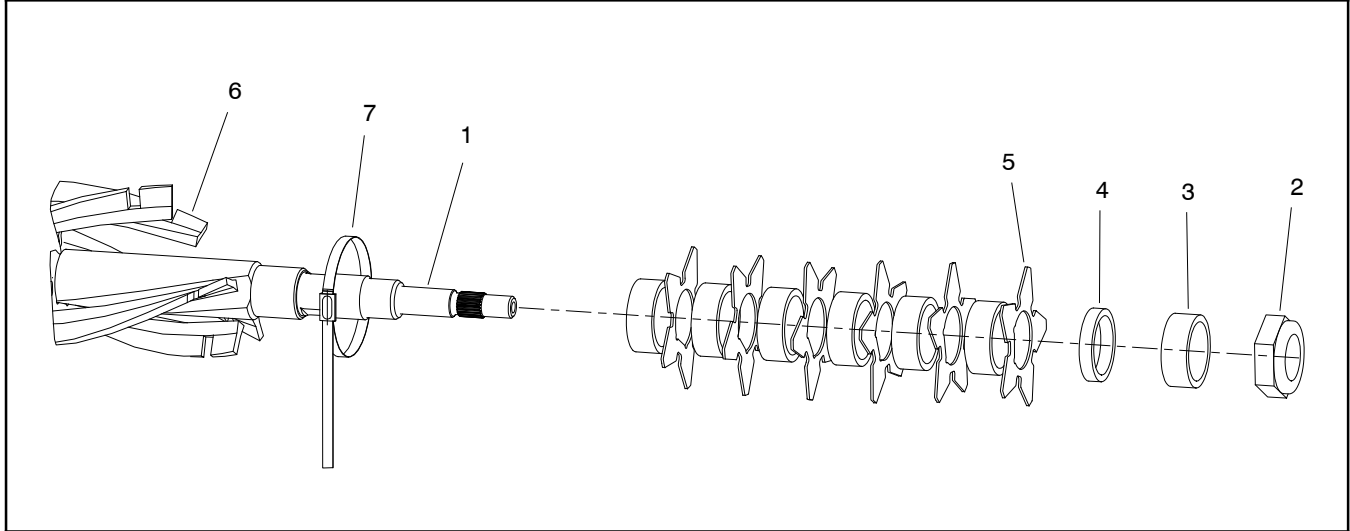


Figure 14

- | | | |
|-----------------------------|----------------------------|---------------------------|
| 1. Groomer shaft | 4. Spacer (thin) (2 used) | 6. Broomer brush (5 used) |
| 2. Lock nut (2 used) | 5. Groomer blade (40 used) | 7. Broomer strap (4 used) |
| 3. Spacer (thick) (41 used) | | |

Inspect groomer reel blades frequently for damage and wear. Straighten bent blades with a pliers. Either replace worn blades or reverse the blades to put the sharpest blade edge forward (Fig. 15). Blades that are rounded to the midpoint of the blade tip must be reversed or replaced for best groomer performance.

Disassembly (Fig. 14)

1. Remove groomer reel from cutting unit (see Groomer Reel in this section).
2. Remove excluder seals from groomer reel.
3. If groomer reel is equipped with broomer kit, remove straps and broomer brushes from reel.
4. Remove lock nut from either end of the shaft.
5. Remove spacers and blades from groomer shaft. If needed, remove second lock nut from shaft.

Assembly (Fig. 14)

1. Install lock nut on drive end of groomer shaft. Place thick spacer, thin spacer and then first blade on shaft.
2. Alternately install thick spacers and blades making sure that all blades are separated by a spacer.
3. When all blades have been installed, place thin spacer and final thick spacer on shaft and then thread second lock nut onto the shaft. Center blades on shaft with lock nuts.

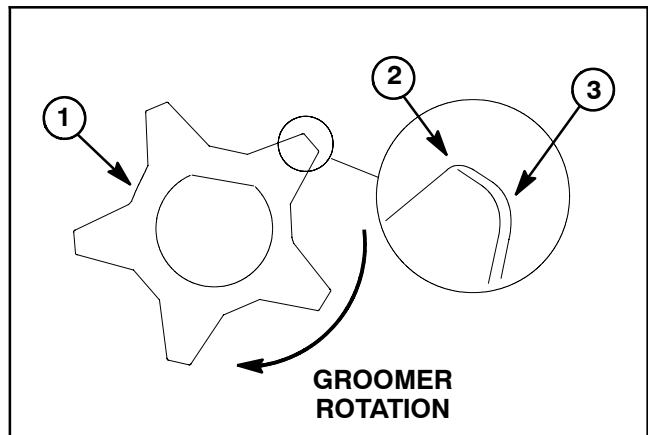


Figure 15

- | | |
|------------------|------------------------|
| 1. Groomer blade | 3. Dull (rounded) edge |
| 2. Sharp edge | |

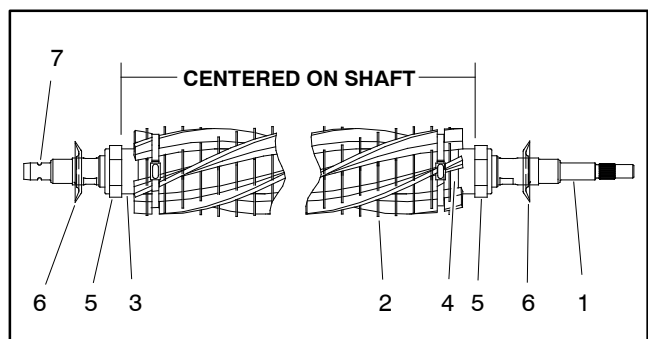


Figure 16

- | | |
|----------------------------|----------------------|
| 1. Groomer reel shaft | 5. Lock nut (2 used) |
| 2. Groomer blade (40 used) | 6. Excluder seal |
| 3. Thick spacer (41 used) | 7. O-ring groove |
| 4. Thin spacer (2 used) | |

4. Using wrench on shaft flats to prevent shaft from turning, torque second lock nut from **375 to 425 in-lb (43 to 48 N-m)**. After torquing lock nut, spacers should **not** be free to rotate and groomer blades should be centered on shaft.

5. If groomer reel is equipped with broomer kit, position broomer brushes to reel blades and secure with straps. Straps should be wrapped around the groomer assembly as shown in Figure 17 and between blades 1-2, 14-15, 28-29 and 41-42. Pull straps tight and cut off strap extension approximately 1/4" (6 mm) beyond retainer.

6. Apply a film of grease onto excluder seal lips and slide seals onto groomer shaft. Excluder seal ID should be located on groomer shaft surface that is recessed slightly.

7. Install O-ring on non-drive end of groomer shaft.

8. Install groomer reel back on cutting unit (see Groomer Reel in this section).

9. Check groomer reel height and mower height-of-cut settings. Adjust as needed.

10. Lubricate groomer bearings.

11. Install cutting unit back on machine.

NOTE: After greasing groomer bearings, operate groomer for thirty (30) seconds, stop machine and wipe excess grease from groomer shaft and seals.

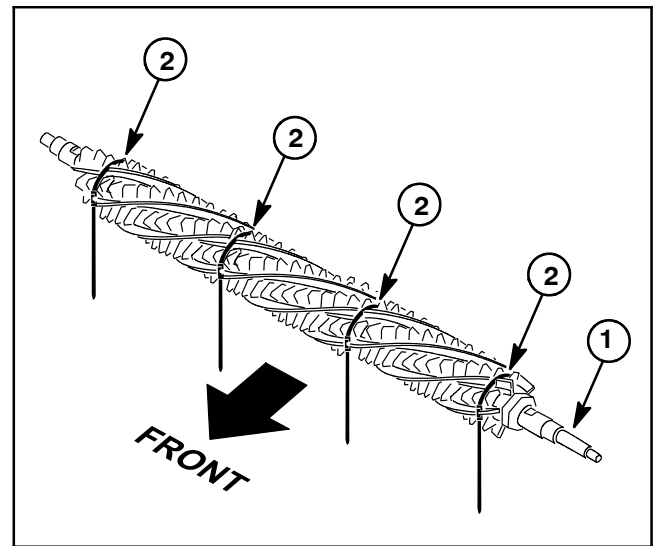


Figure 17

1. Groomer shaft

2. Broomer strap

Height Adjuster Assembly

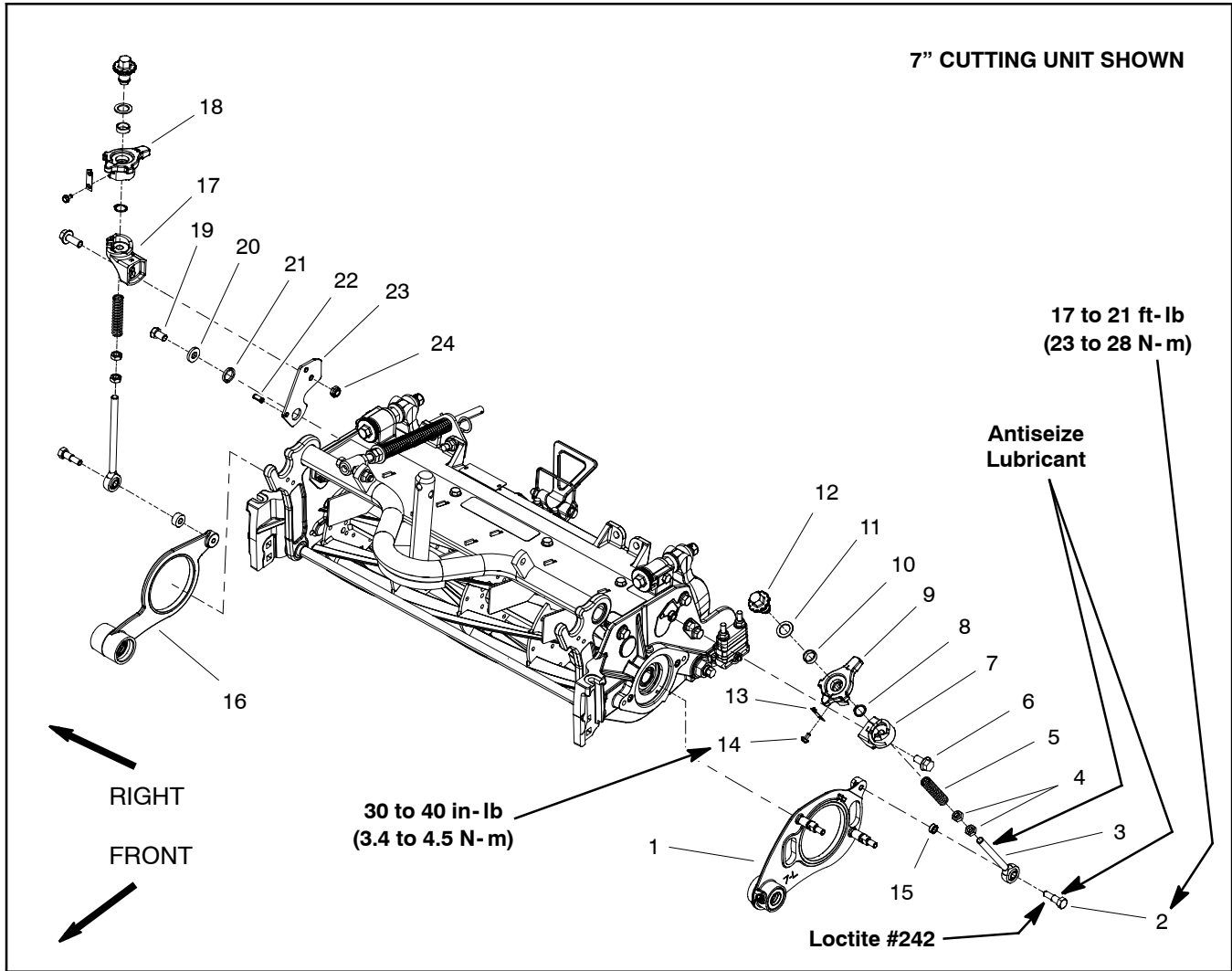


Figure 18

- | | | |
|-------------------------------|------------------------------------|-------------------|
| 1. Groomer plate (drive side) | 9. LH upper ramp | 17. RH lower ramp |
| 2. Shoulder bolt | 10. Bushing | 18. RH upper ramp |
| 3. Ball joint rod | 11. Flat washer | 19. Cap screw |
| 4. Jam nut | 12. Groomer adjuster | 20. Spacer |
| 5. Compression spring | 13. Detent spring | 21. Spacer |
| 6. Flange head screw | 14. Washer head screw | 22. Roll pin |
| 7. LH lower ramp | 15. Spacer | 23. Groomer plate |
| 8. External snap ring | 16. Groomer plate (non-drive side) | 24. Lock nut |

NOTE: The groomer reel drive is located on the opposite side of the cutting unit from the cutting reel hydraulic motor. Figure 18 shows components used when the groomer reel drive is on the left side of the cutting unit.

Disassembly (Fig. 18)

1. Park machine on a clean and level surface, lower cutting units completely to the ground, stop engine, engage parking brake and remove key from the ignition switch.

2. To prevent unexpected reel motor operation, disconnect motors from the electrical power supply by unplugging the 48 VDC battery disconnect (see 48 VDC Battery Disconnect in the General Information section of this chapter).

3. Disassemble height adjuster as needed using Figure 18 as a guide.

4. Clean all height adjuster components and inspect for wear or damage. Replace all worn or damaged components.

Assembly (Fig. 18)

1. Assemble height adjuster using Figure 18 as a guide noting the following items:

NOTE: On 7" cutting units, the ball joint rod on the cutting unit motor side is longer than the ball joint rod used on the groomer drive side of the cutting unit. On 5" cutting units, the ball joint rods are identical.

A. If bushing (item 10) was removed from upper ramp, press new bushing into housing fully to the shoulder in the bore.

B. If jam nuts (item 4) were removed from ball joint rod, apply antiseize lubricant to threads of rod where jam nuts will be positioned. Install jam nuts so that distance from top of ball joint rod to bottom of lower nut is from **3.190" to 3.310" (8.1 to 8.4 cm)**.

C. Apply antiseize lubricant to threads of ball joint rod before installing groomer adjuster (item 12) onto rod.

D. If detent spring (item 13) was removed, secure detent spring to upper ramp with washer head screw. Torque screw from **30 to 40 in-lb (3.4 to 4.5 N-m)**.

2. Apply antiseize lubricant to shoulder area of shoulder bolt that secures ball joint rod to groomer plate and apply Loctite #242 (or equivalent) to threads of shoulder bolt. Position spacer between ball joint rod and groomer plate. Install shoulder bolt and torque from **17 to 21 ft-lb (23 to 28 N-m)**.

3. Check groomer reel height and adjust as needed.

4. After groomer height has been adjusted, adjust location of jam nuts so compression spring length is from **1.320" to 1.440" (3.4 to 3.6 mm)** when the groomer handle is in the disengaged position (handle toward rear of cutting unit) (shown in Fig. 19 For 5" cutting unit and Fig. 20 For 7" cutting unit).

5. Plug the 48 VDC battery disconnect back in before operating the machine.

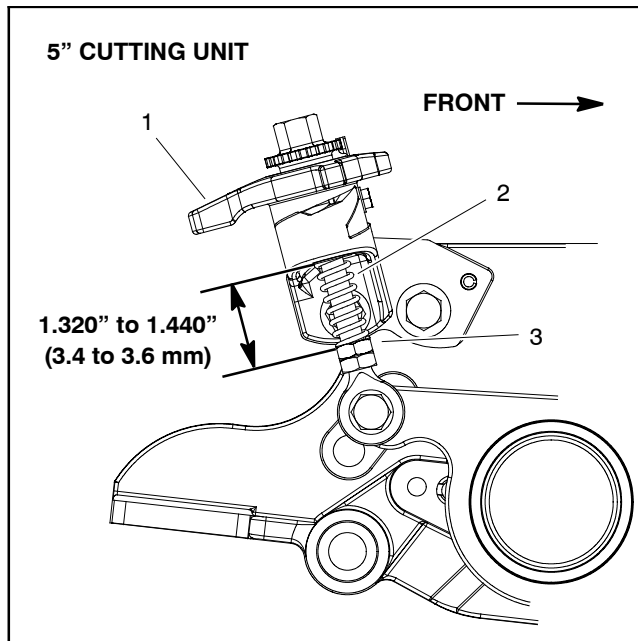


Figure 19

- 1. Groomer handle
- 2. Compression spring
- 3. Upper jam nut

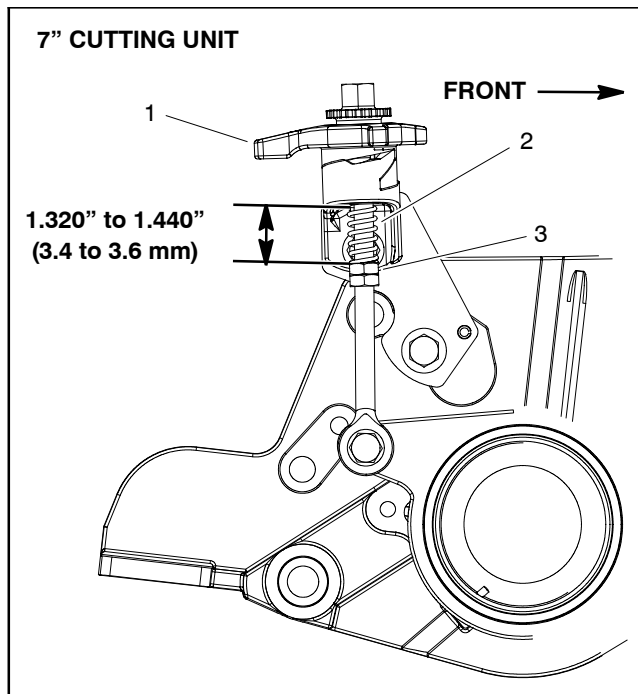


Figure 20

- 1. Groomer handle
- 2. Compression spring
- 3. Upper jam nut

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Foldout Drawings

Foldout
Drawings

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Electrical Drawing Designations

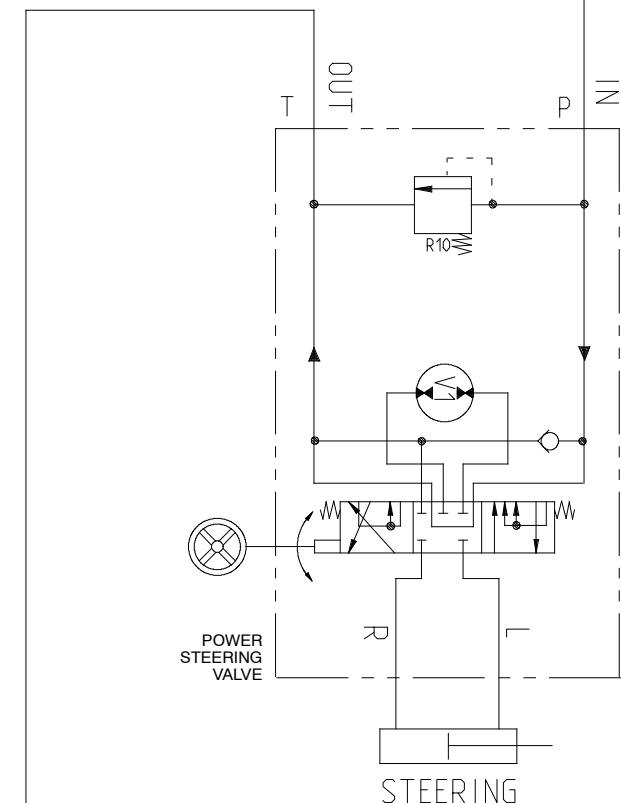
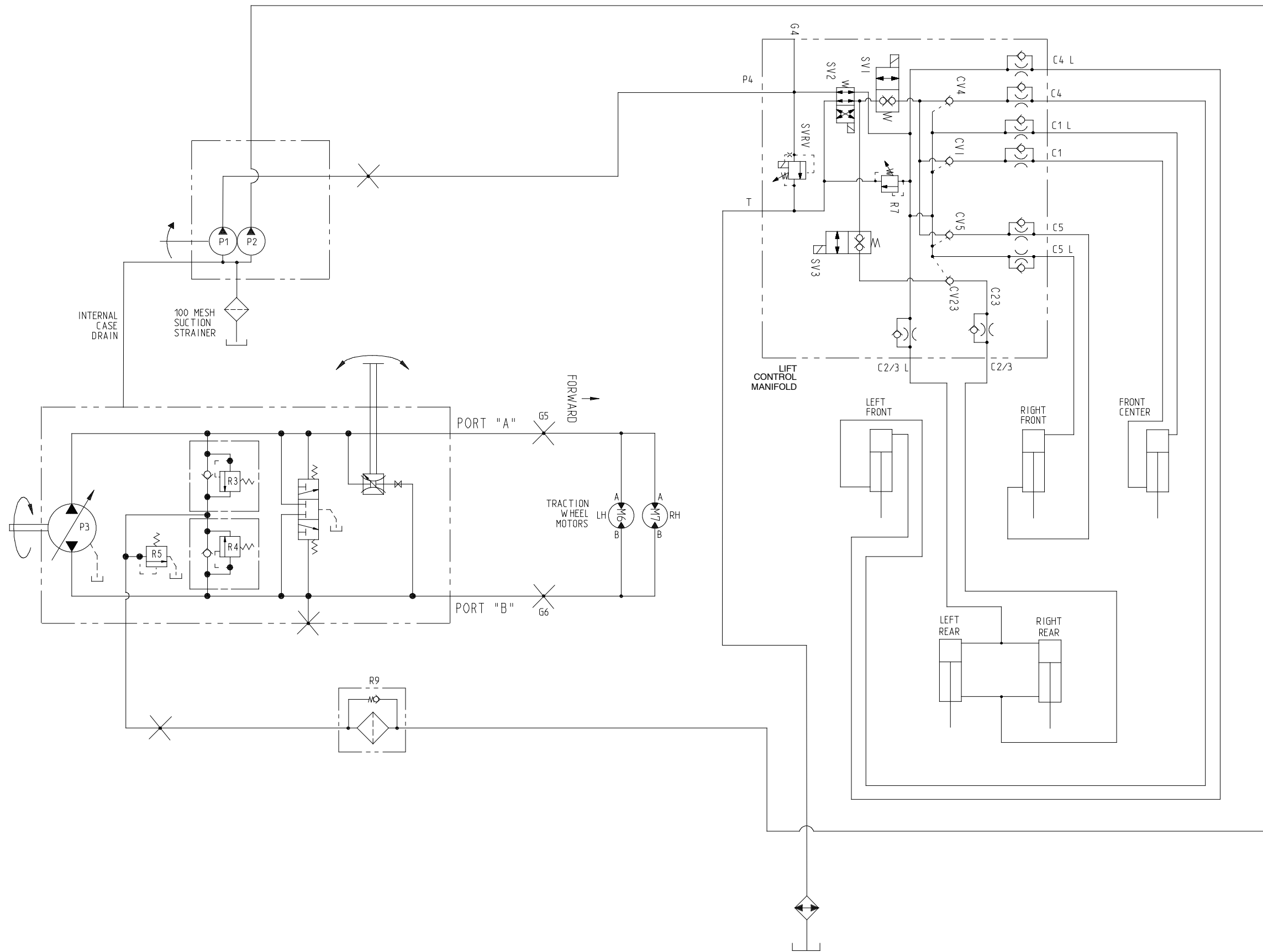
The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

<u>ABBREVIATION</u>	<u>COLOR</u>
BK	BLACK
BR or BN	BROWN
BU	BLUE
GN	GREEN
GY	GRAY
OR	ORANGE
PK	PINK
R or RD	RED
T	TAN
VIO	VIOLET
W or WH	WHITE
Y or YE	YELLOW

Numerous harness wires used on Reelmaster machines include a line with an alternate color. These wires are identified with the wire color and line color with either a / or _ separating the color abbreviations listed above (e.g. R/BK is a red wire with a black line, OR_BK is an orange wire with a black line).

NOTE: The electrical harness drawings in this chapter identify both the wire color and the wire gauge. For example, 16 BK on a harness diagram identifies a 16 gauge wire that has a black insulator.

NOTE: A splice used in a wire harness will be identified on the wire harness diagram by SP. The manufacturing number of the splice is also identified on the wire harness diagram (e.g. SP01 is splice number 1).

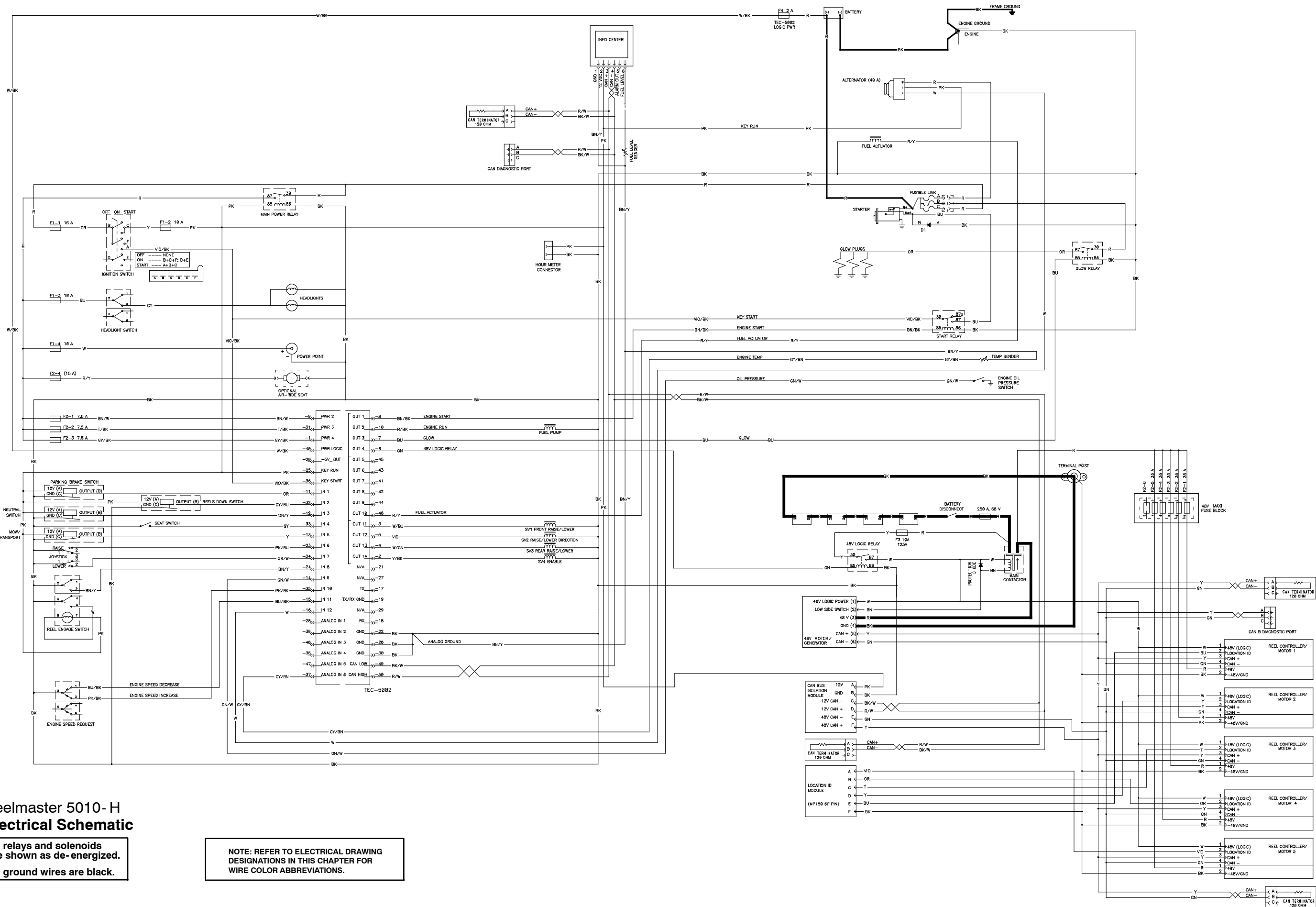


DISPLACEMENT, FLOW RATE, AND PRESSURE CHART

COMPONENT	DISPLACEMENT		PRESSURE		FLOW RATE *	
	in ³ /rev	cm ³ /rev	lbs/in ²	BARS	GPM	LPM
P1	.24	3.96			3.0	11.4
P2	.40	6.61			4.7	17.8
P3	2.14	35			27.2	103
M6	24.7	405				
M7	24.7	405				
V1	6.1	100				
R3			3625	250		
R4			3625	250		
R5			200	14		
SVRV			2000	138		
R7			500	35		
R9			50	3.4		
R10			1000	70		

* FLOW RATE CALCULATED AT 3000 RPM AND 98% EFFICIENCY.

**Reelmaster 5010-H
Hydraulic Schematic**

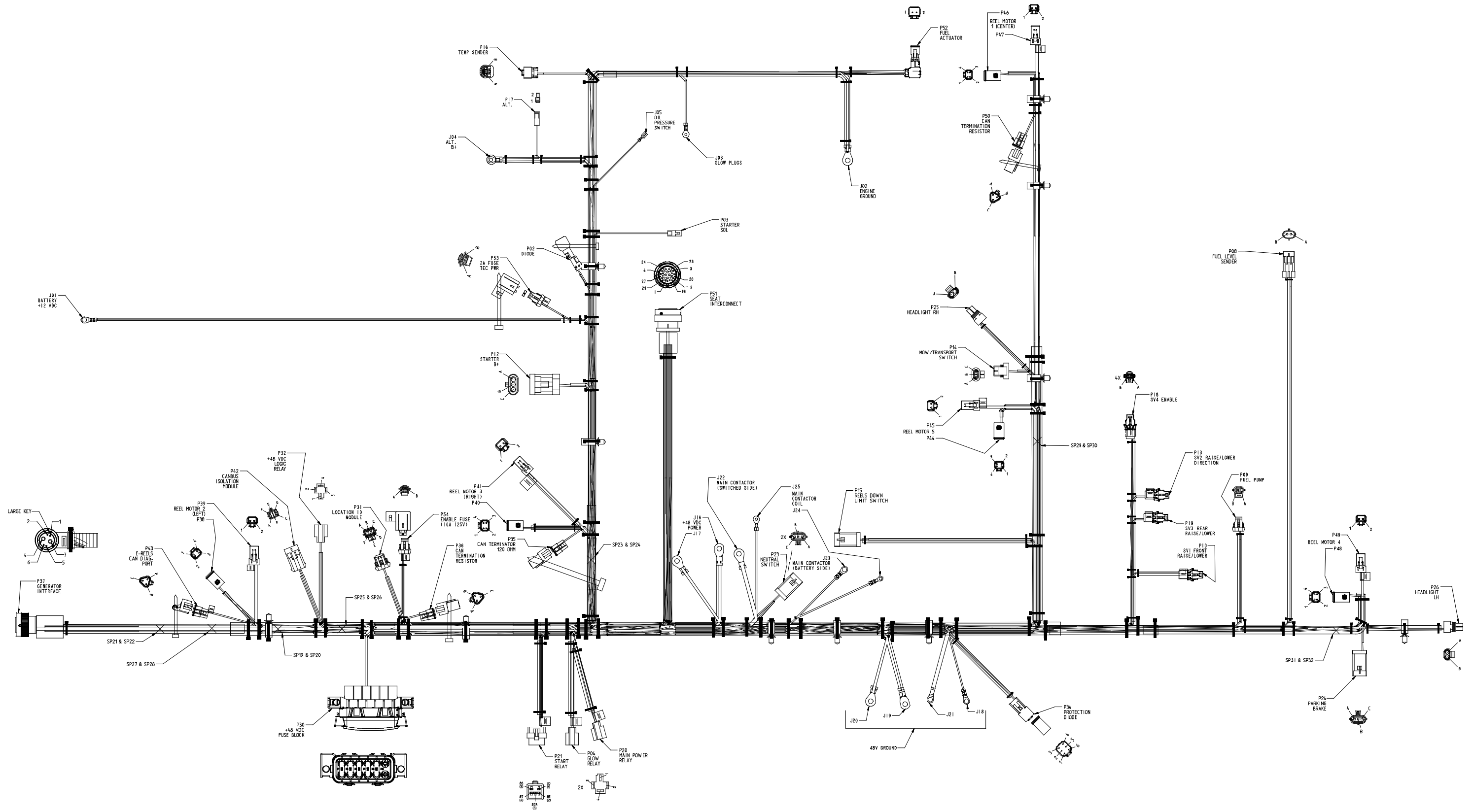


Reelmaster 5010-H Electrical Schematic

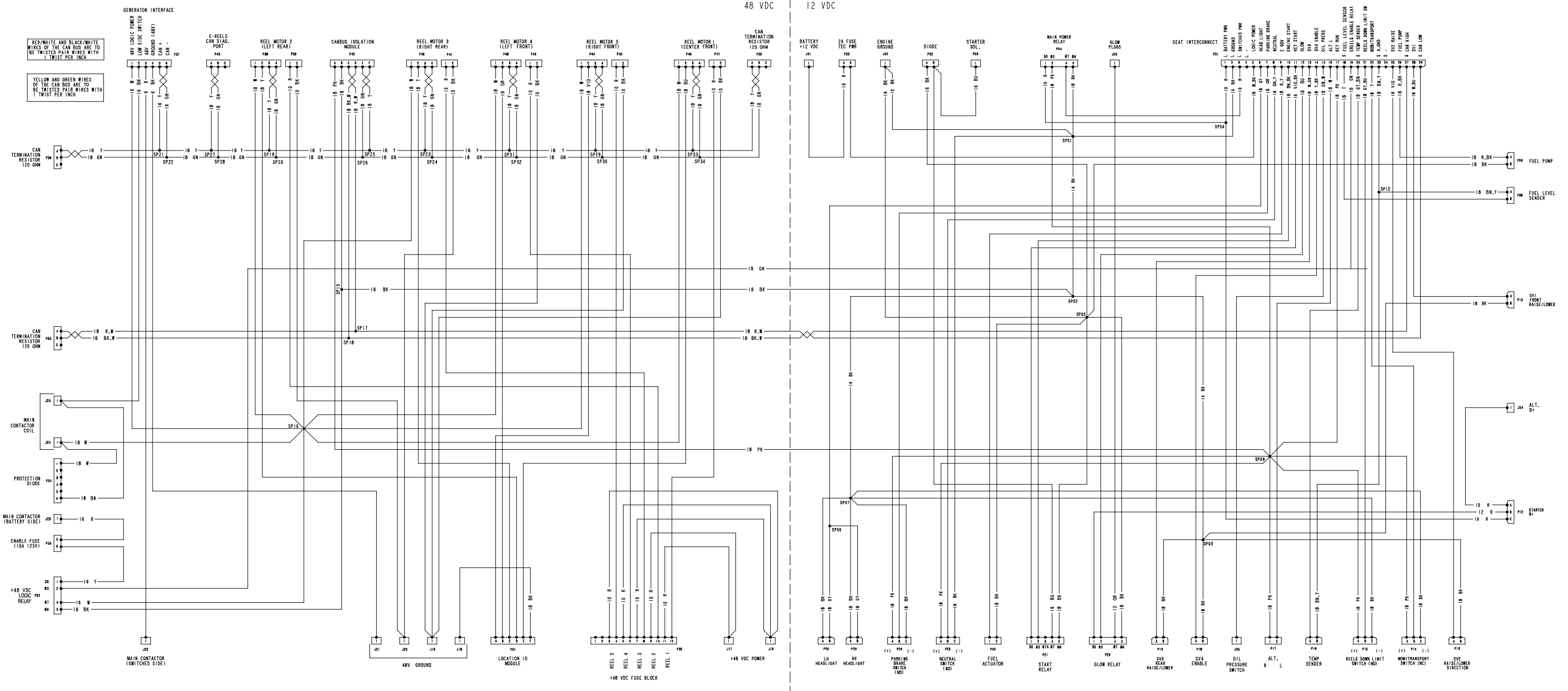
All relays and solenoids are shown as de-energized.
All ground wires are black.

NOTE: REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR WIRE COLOR ABBREVIATIONS.

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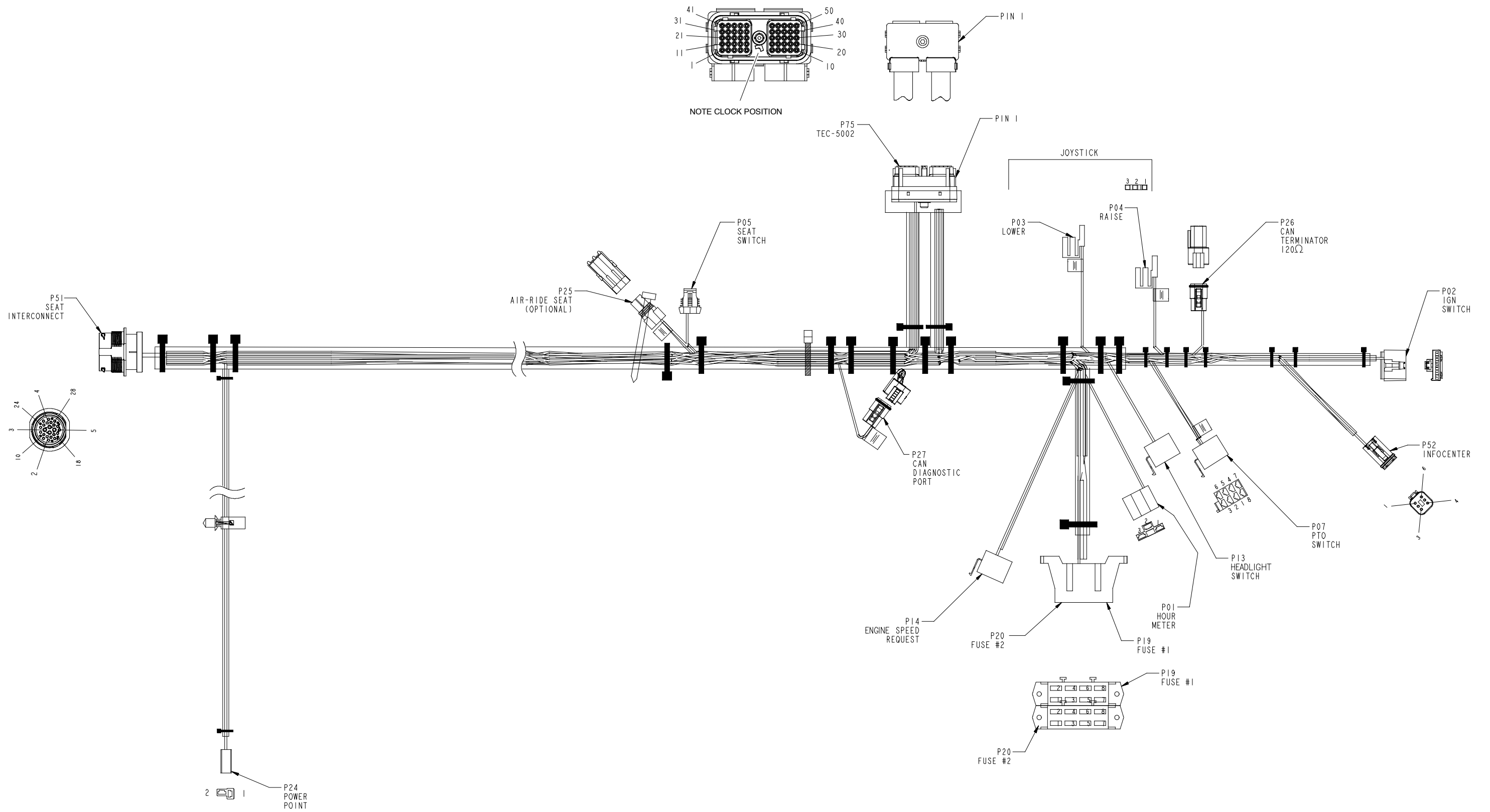


Reelmaster 5010-H
Main Wire Harness Drawing



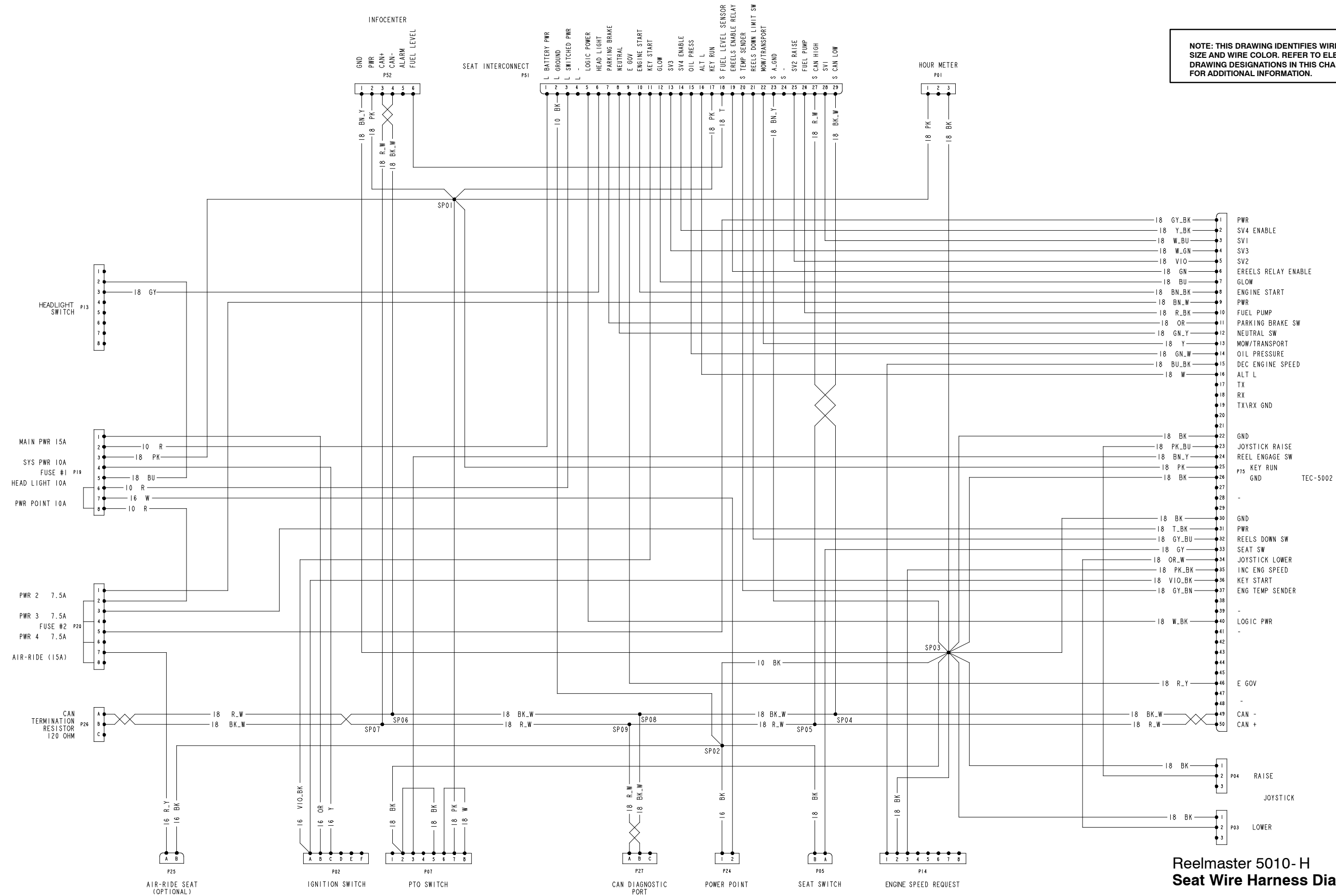
NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.

Reelmaster 5010-H
 Main Wire Harness Diagram



Reelmaster 5010- H
 Seat Wire Harness Drawing

NOTE: THIS DRAWING IDENTIFIES WIRE GAUGE SIZE AND WIRE COLOR. REFER TO ELECTRICAL DRAWING DESIGNATIONS IN THIS CHAPTER FOR ADDITIONAL INFORMATION.



**Reelmaster 5010- H
Seat Wire Harness Diagram**